

Current Northeast Paleoethnobotany II

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This volume is dedicated to the late
Frances B. King, Elizabeth A. Little, and James B. Petersen,
each of whom made substantive, lasting contributions
to paleoethnobotany in the Northeast

TABLE OF CONTENTS

List of Figures	viii
List of Tables	ix
Preface	xi
Chapter 1: Introduction	1
<i>John P. Hart</i>	
Chapter 2: Current Issues in Paleoethnobotanical Research from Pennsylvania and Vicinity	9
<i>Mark A. McConaughy</i>	
Chapter 3: The Impact of Maize-based Agriculture on Prehistoric Plant Communities in the Northeast	29
<i>Nancy Asch Sidell</i>	
Chapter 4: So Little Maize, So Much Time: Understanding Maize Adoption in New England	53
<i>Elizabeth S. Chilton</i>	
Chapter 5: Dichotomies and the “Maize Debate” in Late Woodland and Contact Period Southern New England	61
<i>Ninian R. Stein</i>	
Chapter 6: Maize Agriculture in Coastal Rhode Island: Imaginative, Illusive, or Intensive?	73
<i>Tonya Largy and E. Pierre Morenon</i>	
Chapter 7: Evolving the Three Sisters: The Changing Histories of Maize, Bean, and Squash in New York and the Greater Northeast	87
<i>John P. Hart</i>	
Chapter 8: Cultigens of the American Northeast: A Phytolith Study	101
<i>Katy Serpa</i>	
Chapter 9: Starch Grain Analysis: Methodology and Applications in the Northeast	111
<i>Timothy C. Messner, Ruth Dickau, and Jeff Harbison</i>	
Chapter 10: Visible Clues: The Analysis of Visible Pottery Residues from New York State with Gas Chromatography/Mass Spectrometry	129
<i>Eleanora A. Reber and John P. Hart</i>	
Chapter 11: Chronology and Evolution of the Green Point Flood Plain and Associated <i>Cucurbita pepo</i>	141
<i>William A. Lovis and G. William Monaghan</i>	
Chapter 12: Settlement and Subsistence Change in the Turn of the First Millenium: The View from the Holedale Site, Brantford, Ontario	151
<i>Robert H. Pihl, Stephen G. Monckton, David A. Robertson, and Robert F. Williamson</i>	
Chapter 13: Late Prehistoric Plant Use in the Western Minas Basin Area, Nova Scotia	173
<i>Michael Deal and Sara Halwas</i>	
Chapter 14: Maize Agriculture in the Colonial Period: A View from Mohegan	183
<i>Jeffrey C. Bendremer and Elaine L. Thomas</i>	

Chapter 15: Exploring New Dimensions in the Study of Archaeological Plants	191
<i>Jack Rossen</i>	
Chapter 16: Domesticated Landscapes of the Prehistoric Northeast	199
<i>John Edward Terrell</i>	
Index	
Plant Common Names	205
Plant Scientific Names	206
Plant Common Names in <i>Current Northeast Paleoethnobotany</i>	
New York State Museum Bulletin 494	209
Plant Scientific Names in <i>Current Northeast Paleoethnobotany</i>	
New York State Museum Bulletin 494	210
Contributors	213

LIST OF FIGURES

Figure 2-1	Figure 1: General location of sites mentioned in this chapter.	10
Figure 3-1	Site location map and forest regions of the Northeast (based on Braun 1950).	31
Figure 3-2.	Wood charcoal from archaeological sites arranged by site/component, from oldest to youngest (left to right) within each forest region.	36
Figure 3-3.	Nutshell density (dashed line) in relation to percentage of oak, hickory, and chestnut wood charcoal (black line) and maize index (dotted line).	37
Figure 3-4.	<i>Iva annua</i> var. <i>macrocarpa</i> , domesticated marshelder.	40
Figure 3-5.	<i>Chenopodium berlandieri</i> , Mansfield Bridge site.	41
Figure 3-6.	<i>Chenopodium berlandieri</i> , Deposit Airport I site.	42
Figure 3-7.	<i>Chenopodium berlandieri</i> , Scudder site.	42
Figure 3-8.	<i>Helianthus annuus</i> var. <i>macrocarpus</i> , domesticated sunflower	43
Figure 3-9.	<i>Helianthus</i> spp., wild/ruderal sunflower.	43
Figure 3-10.	<i>Polygonum erectum</i> , erect knotweed, early season phenotype	44
Figure 3-11.	<i>Nicotiana</i> spp., tobacco.	44
Figure 6-1.	Maize recovered in 1974 from Fort Ninigret (RI15) in Charlestown, Rhode Island.	73
Figure 6-2.	Maize from four archaeological sites in Rhode Island discovered after 1990.	74
Figure 6-3.	Locations of seven archaeological sites in Rhode Island with maize, ordered by year of discovery.	75
Figure 6-4.	Champlain map of Nauset Harbor on Cape Cod in 1605, with enlarged detail (insert) of a house surrounded by a corn field. After Salwen 1978:165.	77
Figure 6-5.	279 calibrated radiocarbon dates from all Rhode Island sites plotted by century from B.C. 4100 to A.D. 1900, and all calibrated maize dates.	83
Figure 7-1.	Simplified two-dimensional fitness landscape (after Sewall Wright 1932).	92
Figure 8-1.	Common disarticulated phytolith types (Madella et al. 2005:253-260)	103
Figure 8-2.	<i>Zea mays</i> ssp. <i>mays</i> inflorescence cross shape phytolith.	104
Figure 8-3.	Articulated dendriform phytoliths – <i>Elymus repens</i> inflorescence.	105
Figure 8-4.	Phytoliths from a leaf of <i>Hordeum pusillum</i>	105
Figure 8-5.	Phytoliths from a leaf of <i>Phalaris caroliniana</i>	106
Figure 8-6.	Phytoliths from an inflorescence of <i>Elymus virginicus</i>	106
Figure 8-7.	<i>Elymus glabriflorus</i> (Vasey ex L. H. Dewey) Scribn. & C. R. Ball section of inflorescence.	106
Figure 8-8.	Phytoliths from a leaf of <i>Zizania palustris</i>	107
Figure 8-9.	Irregular phytolith example from <i>Amaranthus graecizans</i> (not part of this study).	107
Figure 8-10.	Phytoliths from a pod of <i>Phaseolus polystachios</i>	107
Figure 8-11.	Phytoliths from a leaf of <i>Cucurbita foetidissima</i>	108
Figure 9-1.	Calcium oxalate crystals (A) and starch grains (B) from an <i>Arisaema triphyllum</i> (Jack-in-the pulpit) corm, viewed with cross-polarized light.	112
Figure 9-2.	Experimental tools used to process plant material and residue embedded in stone mortar (or nutting stone) as the result of <i>Quercus</i> (acorn) cracking.	113
Figure 9-3.	Examples of modern starch from reference specimens.	116
Figure 9-4.	Map illustrating locations of sites included within this study. (Map by William Schindler).	119

Figure 9-5.	A tabular shale grinding stone (Sample #2) recovered from the Manna site.	120
Figure 9-6.	Grinding stone recovered from Loch Lomond.	120
Figure 9-7.	Archaeological starch grains from Manna and Loch Lomond.	121
Figure 9-8.	Ceramic sherd recovered from Feat. 911.	121
Figure 9-9.	Archaeological starch from Shoemaker's Ferry and modern comparative starch.	122
Figure 10-1.	Map of sites in New York State that provided samples for this study	130.
Figure 10-2.	Total Lipid Extract (TLE) of a visible residue from Vinette 40046. It shows the full range of compounds present in the residue, including amyirin, typical of non-tree plant resin, and cholesterol, a biomarker for the presence of animal products.	132
Figure 10-3.	TLE of a visible residue from Kipp Island 41119-8, showing the free fatty acids present in the residue and the sterol/stanone series typical of manure or coprolites.	135
Figure 10-4.	Neutral fraction of the visible residue from Kipp Island 41119-8, whose TLE is shown in Figure 10-3.	136
Figure 10-5.	Fatty acid methyl ester (FAME) fraction from a visible residue extracted from Kipp Island 41119-5, showing the 18-carbon isoprenoid fatty acids, typical of heat-caused reactions of triunsaturated fatty acids.	137
Figure 11-1	Locations of Archaic archaeological sites with <i>Cucurbita</i> remains in the Midwest and Northeast U.S., and early sites in the Saginaw Bay region, Michigan.	142
Figure 11-2.	<i>Cucurbita</i> (squash and gourds) from the Saginaw Valley discussed in the text.	144
Figure 11-3.	The Green Point area and reconstructed stratigraphy of the Green Point floodplain.	145
Figure 12-1.	The location of the Holmedale site and other Princess Point site clusters in southern Ontario.	153
Figure 12-2.	The setting of the Holmedale site on the Grand River.	156
Figure 12-3.	The excavation of the Holmedale site.	157
Figure 12-4.	The primary occupation area within the settlement area.	158
Figure 12-5.	Plans and profiles of the Holmedale site storage pits.	160
Figure 12-6.	The chronological position of the Holmedale site within the radiocarbon sequence for Princess Point Complex sites. Adapted from Smith (1997).	162
Figure 12-7.	Reconstructed ceramic vessel from the Holmedale site.	163
Figure 13-1:	Study area indicating sites mentioned in text.	173
Figure 13-2:	Sara Halwas using forced-air/froth flotation machine at the MUN lab.	175
Figure 13-3:	Charring experiment at Clam Cove in 2005.	176

LIST OF TABLES

Table 2-1.	Cucurbit remains from Pennsylvania.	11
Table 2-2.	Tobacco (<i>Nicotiana</i> spp.) remains from Pennsylvania.	13
Table 2-3.	Specimens of chenopod from Pennsylvania and the northern West Virginia panhandle.	14–15
Table 2-4.	<i>Polygonum erectum</i> and <i>Polygonum</i> spp. from Pennsylvania.	16
Table 2-5.	Specimens of Little Barley (<i>Hordeum pusillum</i>) recovered from Pennsylvania sites.	17
Table 2-6.	Maygrass (<i>Phalaris caroliniana</i>) remains from Pennsylvania.	17
Table 2-7.	Remains of Marshelder (<i>Iva annua</i>) from Pennsylvania and the northern panhandle of West Virginia	17
Table 2-8.	Sites producing sunflower (<i>Helianthus annuus</i>) remains from Pennsylvania.	18
Table 2-9:	Maize remains from Pennsylvania and vicinity.	20–21
Table 2-10.	Bean (<i>Phaseolus vulgaris</i>) remains from Pennsylvania.	23
Table 3-1.	Latin and common names of plants referenced in the text.	30
Table 3-2.	Sites and data used in constructing figures and tables.	32–33
Table 3-3.	Maize, cucurbit, bean, tobacco, eastern agricultural complex, and wild rice.	34
Table 3-4.	<i>Iva annua</i> , marshelder.	40
Table 3-5.	<i>Chenopodium berlandieri</i> , goosefoot.	41
Table 3-6.	<i>Helianthus</i> spp., sunflower.	44
Table 6-1.	Archaeological sites with early maize in Rhode Island (2006).	80
Table 8-1.	Sources of plant specimens from the Rochester Academy of Science.	102
Table 8-2.	Species and family names of plants examined.	104
Table 8-3.	Number of slides examined for each species.	105
Table 8-4.	Potential for future phytolith research of species examined in this study.	108
Table 9-1.	Subterranean storage organs, ethnographically and ethnohistorically documented as utilized by Native groups of the Eastern Woodlands.	118

Table 10.1.	Radiocarbon dates of samples mentioned in the text.	131
Table 10-2.	Residue type, interpretation, and comments on all residues analyzed in this study, both absorbed and visible.	134–135
Table 11-1.	Key archaeological sites, finds of <i>Cucurbita</i> , and pertinent radiocarbon dates from the Saginaw Valley, Michigan	143
Table 12-1.	Holmedale site plant remains — sample components.	164
Table 12-2.	Holmedale site plant remains — seeds.	165
Table 13-1.	Density (per liter) of seeds recovered from four Minas Basin sites.	175
Table 13-2.	Density (per liter) of conifer needles recovered from four Minas Basin sites.	176
Table 13-3.	Number of identified charcoal specimens from two Minas Basin sites (after Halwas 2006).	177
Table 13-4.	Uses of identified plant specimens suggested by ethnohistoric observations.	178
Table 13-5.	Selected Mi'kmaq terms associated with identified plant specimens.	179
Table 13-6.	Modern Mi'kmaq uses for identified plant specimens.	179
Table 14-1.	Macrobotanical remain counts from Shantok Village.	185
Table 14-2.	Identified terrestrial mammal remain bone counts from Shantok Village.	185
Table 14-3.	Avian and reptile remain bone counts from Shantok Village.	185
Table 14-4.	Fish remain bone counts from Shantok Village.	186
Table 14-5.	Marine shell fragment counts from Shantok Village.	186
Table 14-6.	Macrobotanical remain counts identified at five late eighteenth- to early nineteenth-century Mohegan sites.	187
Table 14-7.	Faunal remain bone counts identified at five eighteenth- to early nineteenth-century Mohegan sites.	188
Table 14-8.	Identified marine shell remain fragment counts from five late eighteenth- to early nineteenth-century Mohegan sites.	188

PREFACE

This is the second volume I have edited on paleoethnobotanical research in the Northeast. The first, published as *Current Northeast Paleoethnobotany*, New York State Museum Bulletin 494 in 1999, was based on a symposium held at the New York State Museum in Albany as part of the New York Natural History Conference IV in April 1996. This current volume is based on a symposium held in San Juan, Puerto Rico, at the 71st annual meeting of the Society for American Archaeology in April 2006. As I relate in the introductory chapter of this volume, a lot had changed in paleoethnobotany in the Northeast during the 10 years between the symposia. Suffice it to say here that the Northeast is more visible than ever in the paleoethnobotanical literature and that the methods, techniques, and theories used by the discipline are much broader than in 1996.

The symposium brought together many of the same participants in the original symposium and volume. Most of the symposium participants were able to contribute chapters to the present volume. These include Nancy Asch Sidell, John P. Hart, Mark A. McConaughy, Katy R. Serpa, Elizabeth S. Chilton, Jeffrey Bendremer and Elaine Thomas, Tonya Largy and E. Pierre Morenon, Michael Deal and Sara Halwas, and Jack Rossen. In addition, I was

able to solicit papers from a number of individuals who had not participated in the symposium, but are doing important paleoethnobotanical research in the Northeast. These are Eleanore A. Reber; Ninian Stein; Tim Messner, Ruth Dickau, and Jeff Harbison; William A. Lovis and G. William Monaghan; and Robert H. Pihl, Stephen G. Monckton, David A. Robertson, and Robert F. Williamson. Finally, John Edward Terrell contributed a commentary on the volume that places the practice of paleoethnobotany in the Northeast in a broader perspective. Collectively, the contributions by these authors provide a sense for the breadth of paleoethnobotanical research being carried out in the Northeast. They also provide a benchmark, as did the 1999 volume, by which progress in the field can be measured in the decades to come.

I thank all of the contributors for helping to make this second *Current Northeast Paleoethnobotany* volume a reality. I also thank Gayle R. Fritz for her timely and thoughtful review of the volume and John B. Skiba for managing the volume's production. Finally, thanks to Patricia Kerrian for the cover illustration.

John P. Hart
February 2008

CHAPTER 1

INTRODUCTION

John P. Hart

In northeastern North America our understandings of prehistoric human–plant relationships, the subject of paleoethnobotany, continue to change as more samples are taken, examined, and compared to extant records. The results of these analyses are no longer relegated to the appendices of archaeological site reports, but constitute important contributions to our understandings of Native American lifeways in the Northeast, on their own and in combination with other lines of evidence. This volume is another such contribution, bringing together a series of chapters that represent some of the range of work being done in this vital field of inquiry.

The chapters in this volume stem from a symposium I organized for the 2006 Society for American Archaeology annual meeting in San Juan, Puerto Rico. The goal of the symposium was to commemorate the tenth anniversary of a symposium that I organized for the 1996 New York Natural Historic Conference at the New York State Museum in Albany. That symposium eventually gave rise to New York State Museum Bulletin 494, *Current Northeast Paleoethnobotany* (Hart 1999a). Beyond that was my desire to bring to the fore progress that had been made in the field over the intervening years. What is the nature of paleoethnobotanical research Northeast in the mid-2000s?

In the 10 years between the two symposia there have been considerable changes in the discipline. Most of these changes are related to analytical techniques that are providing new lines of evidence on prehistoric human–plant interactions. There have also been changes in methods and theories that provide the basis for understanding how humans made use of plants in the past and how those uses impacted other aspects of human behavior. The impacts of these changes are evident in many of the current volume's chapters.

In the 1990s the primary focus on paleoethnobotanical research in eastern North America remained on macrobotanical remains. This is reflected in two important, widely

cited summary publications on the paleoethnobotany of the region (Fritz 1990; Smith 1992) as well as a number of compiled volumes (e.g., Gremillion 1997; Hart 1999a; Scarry 1993). Today, macrobotanical remains continue to play significant roles in our understandings of human–plant relationships as demonstrated by many of the chapters in this volume (also see e.g., chapters in Minnis 2003). Asch Sidell's chapter is an excellent demonstration of how painstakingly accumulated macrobotanical data can be used to address long-term changes in human–plant relationships and the impacts of the adoption of maize on those relationships over large expanses of territory (also see Asch Sidell 1999, 2002). McConaughy's review and summary of paleoethnobotanical data from Pennsylvania, building on an earlier summary by King (1999), is another such example. Both of these chapters illustrate the use of indigenous eastern North American crops in the Northeast in addition to the well-documented use of indigenous cucurbits. In need of resolution is the extent to which these crops were in use prior to the widespread use of maize.

In their chapter, Largy and Morenson show how careful assessments of even moderate amounts of macrobotanical remains can help clarify regional issues in paleoethnobotany, such as the use of maize in coastal Rhode Island. Bendremer and Thomas provide a case study that links the prehistoric and historical archaeological records and the written historical record of maize use in Connecticut with current use among the Mohegan. Lovis and Monaghan combine macrobotanical and geoarchaeological analyses to gain new insights into the early use of squash in Michigan. Pihl and colleagues use macrobotanical remains to aid in the interpretation of the Holmesdale site in southern Ontario. They use the results to help us understand regional variation in maize agriculture several centuries after the first macrobotanical evidence for the crop in that region (Crawford et al. 1997). Deal and

Halwas provide an overview of the results of paleoethnobotanical research in the Western Minas Basin of Nova Scotia. Their work demonstrates the value of combining macrobotanical evidence with that from the ethnohistoric record for elucidating prehistoric plant use in this area where agricultural crops were not used.

In the 1990s microbotanical remains in northeastern North America received less general notice and appreciation. In some areas of research it is microbotanical remains, however, that play the most prominent roles (e.g., Piperno 1998). While pollen has been a component of paleoethnobotanical studies for decades (e.g., Almquist-Jacobson and Sanger 1999; Fearn and Liu 1995; Sears 1982; Whitehead 1965; Whitehead and Sheehan 1985), today our understandings of crop histories are being altered, often radically, as a result of the analyses of microbotanical remains such as lipids, phytoliths, and starches, as well as molecular evidence such as ancient DNA. While pursued for many years, these analyses have only gained broad acceptance over the past decade, and it is no longer possible to understand the full histories of crops in any region of the world without considering them. We are only beginning to take advantage of these lines of evidence in the Northeast.

Phytoliths are silicate structures found in plants cells. The potential of these structures to inform paleoethnobotanical studies has long been recognized (Pearsall 1982; Rovner 1983). The analysis of phytoliths recovered from sediments at archaeological sites has been used to elucidate crop histories in the tropics since the 1970s (e.g., Pearsall 1978; Pearsall et al. 2003; Piperno 2004; Piperno et al. 1985; Piperno and Flannery 2001; Piperno and Pearsall 1998; Piperno and Stothert 2003). However, there was, until recently, very little use of this potential source of evidence for crop histories in eastern North America (e.g., Bozarth 1987, 1990, 1993; Mulholland 1993), including the Northeast (Starna and Kane 1983).

More recently, efforts have been made to extract and analyze phytoliths from more secure contexts such as charred cooking residues adhering to the interiors of pottery sherds (e.g., Boyd et al. 2006; Chávez and Thompson 2006; Lusteck 2006; Staller and Thompson 2002; Thompson 2005a, 2005b; Thompson et al. 1994). Over the past several years, my colleagues and I have done analyses of phytolith assemblages recovered from directly AMS dated cooking residues from sites in central New York (Hart et al. 2003, 2007a, 2007b; Thompson et al. 2004). As related in my chapter in this volume, the results of these analyses have changed our understanding of the histories of maize (*Zea mays* ssp. *mays*) and squash (*Cucurbita* sp.) considerably. They have also provided evidence that wild rice (*Zizania aquatica*) and sedges (*Cyperus* sp.) were also being cooked in pottery and that grass seeds (possibly little barley [*Hordeum pusillum*]), were

being processed in 3,500-year-old steatite vessels. In her chapter in this volume Serpa reviews the results of a pilot program for building a comparative collection of phytoliths specifically for the Northeast. She confirms that several plant species have high potential for phytolith research in the region. While published phytolith investigations in the Northeast have been restricted to New York, this technique has a great deal of potential to advance our understandings of crop histories throughout the larger region in the coming years.

Starch grain analysis has a shorter history. As related by Messner et al. (this volume), it was only in the mid-1990s when the analysis of starch grains in paleoethnobotany was realized (Cortella and Pochettino 1994; Loy 1994; but also see Ugent et al. 1984). Analysis of starch grains has been an important source of new information about crop histories in the tropics over the last decade (e.g., Dickau 2005; Perry 2002; Perry et al. 2007; Piperno and Holst 1998). It was not until the last few years that attempts were made to analyze starch grains in the Northeast. Messner and Dickau (2005) demonstrated that starch grains preserve in the microtopography of stone tools in Pennsylvania. In the present volume Messner and colleagues show that starch grains also preserve in charred cooking residues on pottery sherds at the Pennsylvania sites (also see Boyd et al. 2006). While the results are limited at this time to relatively recent contexts in Pennsylvania, this technique, like phytolith analysis, has great potential to change our understandings of prehistoric human-plant relationships in the Northeast.

The analysis of fatty acids recovered from prehistoric pottery has a long history (e.g., Eerkens 2005; Evershed et al. 1992; Passi et al. 1981), including applications in the Northeast (Deal 1990; Deal et al. 1991; Deal and Silk 1988; Fie et al. 1990). Most recently, in eastern North America, Reber and colleagues (Reber et al. 2004a, 2004b; Reber and Evershed 2004, 2006) have pursued evidence for maize cooking in late prehistoric pottery from the Mississippi Valley. They have been able to identify a rare specific marker for maize that can be confirmed through mass spectrometry/gas chromatography analysis. Reber has also extracted lipids from both pottery sherd fabric and encrusted cooking residues on pottery and steatite sherds from New York. While not providing specific identifications of crops, as reviewed by Reber and Hart (this volume) these analyses have led to the identification of pine processing in the vessels. Lipids produced by pine resins been identified in 3,500-year-old residues on steatite sherds (Hart et al. 2008) as well as pottery sherds from early contexts through late prehistory (Reber and Hart 2008, this volume). Two hypothesis that may explain the presence of pine resin is that it was used to seal the vessels or that decoctions of white pine needles were prepared as a rich source of vitamin C to cure and avoid

scurvy. The use of pine as a medicinal resource has been documented among the northern Iroquois ethnohistorically (Hosbach 1994; Moerman 1986), and ethnographically and historically as a pottery vessel sealant in several areas of the world (e.g., Beck et al. 1989; Longacre 1981; Schiffer et al. 1994). However, it has not been identified previously as a prehistoric resource in New York for either of these purposes.

The combined data from phytolith and lipid analysis of residues has already been shown to have great potential to increase our understandings of plant processing and vessel use (e.g., Hart et al. 2008). Such results can be enhanced further by the analysis of starches recovered from the same residues. The need to combine evidence from numerous lines of paleobotanical evidence including both macro- and microbotanical remains has been recently demonstrated by Smalley and Blake (2003) in Mexico. A sole reliance on macrobotanical remains to assess the histories of crops or the ranges of subsistence activities of a particular component or region is no longer tenable. As I discuss in my chapter in this volume, there is a strong need to tie to theory the methods and techniques used to develop lines of evidence about prehistoric plant-human relationships.

Another line of evidence extracted from charred cooking residues adhering to the interior surfaces of pottery has recently been questioned. Several studies have used isotope values from residues to assess whether or not maize had been cooked in a pot (e.g., Beehr and Ambrose 2007; Hastorf and DeNiro 1985; Morton and Schwarcz 2003; Schulenberg 2002). The underlying assumption is that there is a linear relationship between the proportion of maize cooked in a pot relative to C3 resources and the resulting $\delta^{13}\text{C}$ values (e.g., Morton and Schwarcz 2003; see Hart et al. 2007b). However, a series of experiments have demonstrated that the relationship can be non-linear and that the non-linear relationship depends on the resources cooked in the pot (Hart et al. 2007b). In the end, it is necessary to know in advance what resources were cooked in a pot and in what proportions before a carbon isotope value can be interpreted. This is an issue that needs additional experimental work to determine the relationships between the foods cooked in pots, the resulting charred cooking residues, and carbon isotope values.

Important information has been gained over the last few decades on the evolutionary history of crops through isozymic and DNA analyses. Analyses of modern plant isozymes and DNA have shown that the squash subspecies of *Cucurbita pepo* ssp. *ovifera* evolved from gourds indigenous to eastern North America (Decker 1988; Decker-Walters et al. 1993, 2002; Paris et al. 2003; Sanjur et al. 2002). Similarly, isozyme analysis of modern maize samples have shown that Northern Flint has a level of

genetic differentiation from other maize varieties that is typical of separate species (Doebley et al. 1986). This was subsequently confirmed through DNA analysis (Camus-Kulandaivelu et al. 2006). DNA analysis of modern maize and teosinte has helped to reconstruct the history of maize's evolution and dispersals (e.g., Matsuoka et al. 2002), investigate the relationships between maize varieties from the Great Plains (Moeller and Schaal 1999) and North American popcorns (Santacruz-Varela et al. 2004), and reconstruct the dispersal histories of maize in the Old World (e.g., Gauthier et al. 2002; Rebourg et al. 2001, 2003). DNA analysis of macrobotanical remains from archaeological sites is helping to elucidate the histories of maize in the tropics (Freitas et al. 2003; Jaenicke-Després et al. 2003; Jaenicke-Després and Smith 2006). Protein and genetic analysis has also been used to track the evolutionary and dispersal histories of the common bean (e.g., Gepts and Bliss 1986; Gepts et al. 1986; Singh et al. 1991; Sonnante et al. 1994). To date, there have been no such studies published that focus specifically on northeastern North America. A quantitative trait analysis of maize landraces from the St. Lawrence-Great Lakes region (Azar et al. 1997) and large regional genetic analyses (e.g., Camus-Kulandaivelu et al. 2006; Matsuoka et al. 2002) suggest the possibility that DNA analysis of traditional crops in the Northeast could yield information that would enable a better understanding of crop histories in the region. As ancient DNA techniques become more refined in the coming years, this also may be an avenue that will contribute substantively to our understandings of crop histories in the Northeast.

Another important advance in our knowledge of crop histories has been direct accelerator mass spectrometry (AMS) dating of crop remains becoming a standard practice. This technique had been used in several studies by the mid-to-late-1990s to help resolve chronological issues of crops at specific sites (e.g., Bendremer et al. 1991; Cassedy and Webb 1999; Hart 1999b; Hart and Asch Sidell 1997; Petersen and Asch Sidell 1996). These extended the known range of early cucurbit use in eastern North America to the Northeast (Hart and Asch Sidell 1997; Petersen and Asch Sidell 1996), and also demonstrated that crops were not as early as thought on some sites (Asch Sidell 1999; Cassedy and Webb 1999; Hart 1999b), paralleling trends in other areas of the East (e.g., Conard et al. 1984). Subsequently, AMS dating has helped to resolve long-standing issues of crop histories in larger regional studies. Crawford et al. (1995) published an important article documenting the presence of maize macrobotanical remains in southern Ontario by 1551±78 B.P. (cal. 2σ 1605-1302 B.P.). Phytoliths from directly AMS dated charred cooking residues indicate the presence of maize in central New York by 2270±35 B.P. (cal. 2σ 2348-2157 B.P.) (Hart et al. 2007a). AMS dating of bean macro-

botanical remains from across the Northeast indicated that there is no substantiated evidence for this crop before c. 750 B.P. (Hart et al. 2002; Hart and Scarry 1999). No phytolith evidence has been found for bean at older times. Most recently, Monaghan et al. (2006; Lovis and Monaghan, this volume) directly dated gourd remains from Michigan indicating use by 3840±40 B.P. (cal. 2σ 4411-4103 B.P.) and use of squash by 2820±40 B.P. (cal. 2σ 3064-2803 B.P.). There are numerous other examples of AMS dating crop remains that have helped to sort out our understandings of regional agricultural chronologies in the Northeast (e.g., Chilton 2006). What is becoming increasingly clear is that relying on spatially associated charcoal to obtain dates for crops is untenable and that AMS dating used in conjunction with microbotanical research can provide unanticipated results.

Theoretically, there has been a move away from the traditional categories of hunter-gatherer and agriculturist with recognition that such categories hide much of the variation that characterizes human subsistence strategies. However, there is no agreement on what, if any, categories should replace the traditional ones. Smith (1998, 2001), for example, argues for a middle ground between hunter-gatherers and agriculturists that constitutes a vast range of economic patterns. Terrell et al. (2003), on the other hand, suggest doing away with such classifications and focusing instead on the details of subsistence practices; what resources were being exploited, in what proportions, and how these resources were managed. Important to this is a reconceptualization of domestication to: "any species or place may be called domesticated whenever another species knows how to harvest it" (Terrell et al. 2003:325). This definition focuses analyses more formally on the relationships between humans and plants (and animals), and how human behavior affects plant (and animal) populations. What is clear is that the persistent use of traditional categories constrains paleoethnobotanical investigations and may even channel those investigations to specific, anticipated results. In her chapter, Stein explores how traditional dichotomous Western categories, such as forager/farmer and nature/culture, have influenced archaeological conceptualizations of subsistence practices in late prehistoric and early historic southern New England. Chilton explores the concept of mobile farmers and the nature of the archaeological record in New England. Both of these chapters clearly demonstrate the need to carefully assess the underpinnings of our conceptualizations of the past in general and of the nature of prehistoric subsistence specifically.

CONCLUSION

In conclusion, paleoethnobotany today is a very different discipline than it was in 1996. While macrobotanical remains continue to be critical lines of evidence, microbotanical remains are providing important lines of evidence that are helping to shape new understandings of human-plant interactions in the Northeast. Theoretical issues are being reconceived in a manner that makes the past a much more interesting place, where traditional categories no longer have productive roles. As we continue into the latter part of the first decade of the twenty-first century, the Northeast is poised to make continuing important contributions to the discipline, both in terms of substantive studies of macrobotanical and microbotanical remains and in its theoretical development. In their respective chapters, Rossen and Terrell provide insights into how paleoethnobotany in the Northeast is presently situated within the larger field and in relation to trends in other parts of the world. As they both indicate, current Northeast paleoethnobotany can not only benefit from but also benefit the field of paleoethnobotany in other regions of the world.

A NOTE ON RADIOCARBON DATES AND CHRONOLOGY

Unless otherwise noted, all radiocarbon dates presented in this volume have been calibrated with CALIB 5.01 using the IntCal04 dataset. Calibrated dates are presented as 2σ ranges. I have left it up to the individual chapter authors whether to use B.P. (before present) or B.C./A.D. calibrations. Dates preceded by ca. are uncalibrated unless preceded by the abbreviation cal. and are generally date range estimates provided for traditional culture historic periods and taxa.

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CHAPTER 2

CURRENT ISSUES IN PALEOETHNOBOTANICAL RESEARCH FROM PENNSYLVANIA AND VICINITY

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The decade of the 1960s saw a profound change in how archaeology was and is conducted in the United States. Interest became focused on settlement patterns and subsistence practices. Some of these changes were brought about because of criticisms that archaeology needed to be more than simple descriptions of artifacts found at sites and plugging sites into a local chronology. Other changes were brought about by new techniques that were developed, such as flotation, microscopic edge wear studies of lithics, and trace element/mass spectrometer analysis of bone remains that provided a wealth of new information about what went on in the past.

Most of the data for the chapter were gathered after the use of flotation became a common practice at sites in the region. Flotation of soil samples recovered from good archaeological contexts provided the ability to recover small bones, seeds, and plant remains that would have fallen through most 0.125, 0.25 and 0.5 inch mesh hardware cloth normally employed to screen site matrix. Studies conducted largely after 1960 have shown that there was an Eastern Agricultural Complex (Ford 1985), consisting of native plants that were cultivated prior to the intensive adoption of maize horticulture in the eastern United States. Plant species included in the Eastern Agricultural Complex are gourd/squash (*Cucurbita pepo* ssp. *ovifera*), goosefoot (*Chenopodium berlandieri* ssp. *jonesianum*), sumpweed (*Iva annua* var. *macrocarpa*), maygrass (*Phalaris caroliniana*), erect knotweed (*Polygonum erectum*), little barley (*Hordeum pusillum*), and sunflower (*Helianthus annuus* var. *macrocarpus*) (Wymer 1996; King 1999:12). Identification of these remains at sites in Pennsylvania and the eastern United States has drastically altered our view of what people ate and their subsistence practices.

This chapter is primarily directed toward investigations into horticulture practices used by the prehistoric inhabitants from Pennsylvania and the northern panhandle of West Virginia. The later area is included since there

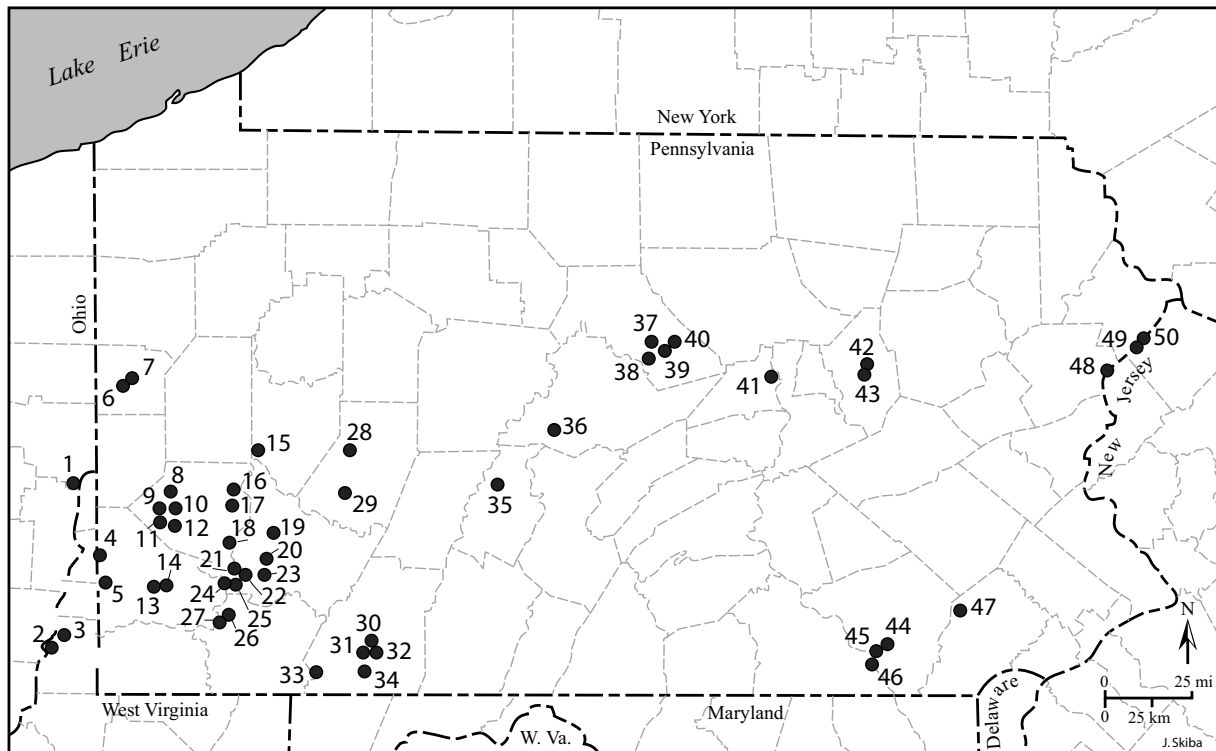
is little difference in the cultural remains recovered from the northern panhandle of West Virginia and those from southwestern Pennsylvania. In fact, some of the type localities for Middle and early Late Woodland groups from southwestern Pennsylvania are located in the panhandle. Modern boundaries were not observed by regional prehistoric inhabitants. Figure 2-1 provides the general location of sites noted in this chapter.

The area of Pennsylvania and the northern panhandle of West Virginia also is a critical area for understanding how early horticultural practices developed and spread from the Midwest into New York and New England. The Allegheny and Susquehanna drainages played significant roles in the transport of people, ideas, technologies and crops between these areas during prehistoric times.

Frances King (1999) produced the first comprehensive summary of paleoethnobotanical data from Pennsylvania. This chapter is an outgrowth of her study. It is also dedicated to her because her untimely death made it impossible for Fran to continue her work. We will all miss her contributions to the understanding of plant use and plant domestication in the region.

HORTICULTURE IN PENNSYLVANIA AND VICINITY—THE DATABASE

The development of horticulture in the eastern United States predates the late Late Woodland/Late Prehistoric period (ca. A.D. 900 to A.D. 1500/European contact). Early horticulture is largely based on growing native Eastern Agricultural Complex plants. The use of many of these Eastern Agricultural Complex plants was well established in Ohio between at least ca. 2050 B.P. and 1150 B.P. (Wymer 1992, 1993, 1996). Unfortunately, data for these horticultural products is not as well documented from Pennsylvania sites.



1. Watson Farm 2. Fairchance Mound & Village 3. Saddle 4. Meadowcroft Rockshelter 5. Dunsfort 6. Coverts Bridge 7. Coverts Crossing 8. McKees Rock Village 9. Mayview Bend 10. Drew 11. Mayview Depot 12. Portman 13. Wylie 3 14. Wylie 1 15. Murphy Old House 16. Barking Road 17. McJunkin 18. Thorpe 19. Ryan 20. Wilkinson 21. Billy #3 22. Backstrum #1 23. Sony 24. Winter Knuckles 25. 36WM610 26. Campbell Farm 27. Crawford Gist 28. Fleming 29. Brant 30. Gnagy #3 31. Pony Farm Triangle 32. Peck #2 33. Railroad 34. Jonas Field 35. Sheep Rockshelter 36. Fisher Farm 37. Memorial Park 38. Bald Eagle 39. West Water Street 40. Nash 41. St. Anthony 42. Bloomsburg Bridge 43. Catawissa 44. Murry 45. Quaker Hills Quarry 46. Nace 47. Piersol II 48. Smithfield Beach 49. Kutay 50. Faucett

Figure 2-1: General location of sites mentioned in this Chapter.

Cucurbits

The earliest well-documented possible cultigen from Pennsylvania is a cucurbit (Table 2-1). Two rind fragments of *Cucurbita pepo* (gourd/squash) from the Memorial Park site in northeastern Pennsylvania were directly AMS dated to 5404 B.P.±552 B.P. (cal. 2σ 5436–2900 B.C.; Hart and Asch Sidell 1997:527). Soil associated with the feature producing the rind fragments was also dated using three bulk soil samples and one wood charcoal to yield a pooled date of 5009 B.P.±53 B.P. (cal. 2σ 3953–3692 B.C.; Hart and Sidell 1997:526). These rind fragments were only 0.7 mm thick (Hart and Asch Sidell 1997:527). King (1985:91) suggested that any cucurbit rind thinner than 2.0 mm was from a wild form of *Cucurbita*. Smith (1992a:41) agrees and applied “King’s rule” to mid-Holocene specimens of cucurbits recovered in the mid-western United States. All were thinner than 2.0 mm and Smith concluded they were from wild cucurbits growing in that region. Conversely, Hart and Asch Sidell (1997:528–530) argue that the early remains from Memorial Park are well outside the range of any known

wild forms of cucurbit. They argue that cucurbit remains in northern Pennsylvania likely required intentional human dispersal through cultivation. Nevertheless, they could not totally rule out ruderal populations developing in areas disturbed by human activities in the Northeast. Thus, minimally it can be stated that the early cucurbits from Memorial Park represent early exploitation of gourds, and possibly represent evidence of early cultivation in the region.

Another *Cucurbita pepo* (squash) rind fragment (one of 10 rind fragments found in this level) from Memorial Park was AMS dated to 2625±45 B.P. (cal. 2σ 835–767 B.C.; Hart and Asch Sidell 1997:531). The second rind sample was associated with Early Woodland Meadowood points. Some of the rind fragments were thicker than 2.0 mm and thus, using “King’s rule,” are domesticated specimens of *Cucurbita pepo* (Hart and Asch Sidell 1997:531). The cucurbit remains from Memorial Park (both the mid-Holocene specimens listed above and these late-Holocene specimens) are the only ones that have been directly AMS dated in Pennsylvania.

Table 2-1: Cucurbit (*Curubita pepo*) remains from Pennsylvania

AMS Radiocarbon Dated Cucurbit Remains from Pennsylvania					
Site	AMS/Associated Charcoal	Sample No.	Radiocarbon Years (B.P.)	Cal. 2 σ Range (B.C./A.D.)	Reference
Memorial Park 36CN164	AMS rind	AA-19129	5404 \pm 552	5467–2928 B.C.	Hart and Asch Sidell 1997:527
Memorial Park 36CN164	AMS rind	AA-19128	2625 \pm 45	903–596 B.C.	Hart and Asch Sidell 1997:531
Sites with Cucurbit Remains with associated radiocarbon dates					
Meadowcroft Rockshelter 36WH297	Assoc. charcoal	SI-1664	3065 \pm 80	1499–1057 B.C.	Adovasio and Johnson 1981; Adovasio, et al. 1998; Cushman 1982:216
Meadowcroft Rockshelter 36WH297	Assoc. charcoal	SI-1668	2820 \pm 75	1208–819 B.C.	Adovasio and Johnson 1981; Adovasio, et al. 1998; Cushman 1982:216;
Meadowcroft Rockshelter 36WH297	Assoc. charcoal	SI-1665	2815 \pm 80	1209–813 B.C.	Adovasio and Johnson 1981; Adovasio, et al. 1998, Cushman 1982:216.
Bald Eagle/Salmon 36CN102	Assoc. charcoal	UGa-4754	1040 \pm 85 (and possibly as old as 1100 based on other material from site)	A.D. 779–1178	Hart and Asch Sidell 1996:26; Hay and Hamilton 1984; King 1999:19
Smithfield Beach 36MR5	Assoc. charcoal	-	890 \pm 60	A.D. 1027–1252	Fischler and French 1991:160
Ryan 36WM23	charcoal	GaK-3729	830 \pm 80		George 1974:16-17
Fisher Farm 36CE35	Assoc. charcoal	UGa-2276	600 \pm 105	A.D. 1030–1285	Hart and Asch Sidell 1996:26; King 1999:19; Willey 1980:138
Sheep Rockshelter 36HU1	charcoal	M-2086, M-1904, M-2084, M-1905, and M-1903	five dates ranging from 500 \pm 100 to 260 \pm 100	A.D. 1285–1634 to A.D. 1449–1953	Berbich 1967; Herbstritt 1988:12
Catawissa Str. III 36CO9	-	Pitt-8, Pitt-76, Pitt-11	Three C14 dates ranging from 1455 \pm 45 to 1280 \pm 35	A.D. 470–663 to A.D. 658–856	Hart and Asch Sidell 1996:25; Herbstritt 1988:10; King 1999:20
Catawissa Str. IV 36CO9		Pitt-12, DIC-3151, Pitt-74 and Pitt-77	Four C14 dates ranging from 1040 \pm 45 to 795 \pm 75	A.D. 891–1148 to A.D. 1040–1382	Hart and Asch Sidell 1996:25; Herbstritt 1988:10; King 1999:20
Wylie 3 36WH283	charcoal	B-33183 to B-58690	Four C14 dates ranging from 780 \pm 60 to 610 \pm 60	A.D. 1050–1383 to A.D. 1281–1420	King 1990; George 2001
Piersol II (or Pearsall in Custer 1996) 36CH339	Minguannan - Late Woodland	Beta-35799 and Beta-36602	810 \pm 80 and 440 \pm 70.	A.D. 1030–1377 and A.D. 1328–1640	From two different Late Woodland Components, Custer 1996:289; Hart and Creameens 1991:175; Egan 1991.
Sites with Cucurbits, associated cultural remains					
Mayview Bend 36AL125	Early Woodland	Beta-96484 to Beta-96496	12 C14 dates ranging from 2990 \pm 80 to 2160 \pm 70	1419–1005 B.C. to 383–46 B.C.	Kellogg et. al. 1998:Table 5; Raymer and Bonhage-Freund 1998:32
Billy #3 36WM717	Middle Woodland Fairchance Phase	-	-	-	George 1992:17
<i>Lagenaria siceraria</i>					
Sheep Rockshelter 36HU1	charcoal	M-2086, M-1904, M-2084, M-1905, and M-1903	five dates ranging from 500 \pm 100 to 260 \pm 100	A.D. 1285–1634 to A.D. 1449–1953	Berbich 1967; Herbstritt 1988:12

In addition to the Memorial Park samples, cucurbit specimens from north central and eastern Pennsylvania have been recovered from Catawissa, Fisher Farm, Bald Eagle/Salmon sites, Smithfield Beach, and Sheep Rockshelter (Table 2-1). The Sheep Rockshelter remains are somewhat problematic because the site was excavated in arbitrary levels that crosscut occupational deposits. Some cucurbit, maize, and bean remains were recovered from lower levels at the site (Bebrich 1967) and might represent Late Archaic (ca. 3000–1000 B.C.) through Middle Woodland (ca. A.D. 1–1000) food debris. They may also represent downward migration of later remains deposited in the shelter or culturally mixed materials due to the excavation techniques employed. These latter scenarios are considered likely because it is in the uppermost levels that relatively large concentrations of domesticated crop remains were recovered (Bebrich 1967). Until botanical remains from the deeper shelter levels are AMS dated and shown to be early, it is herein assumed they came from the various Late Woodland (ca. A.D. 1000–1500) occupations of Sheep Rockshelter. The sample from Catawissa Stratum III appears to be the oldest of the non-Sheep Rockshelter materials. It dates roughly between ca. A.D. 400 and 900 based on associated charcoal dates (King 1999:20). The remaining specimens are largely from Late Woodland/Late Prehistoric contexts and are from domesticated forms.

Kinsey (1975:17) indicates that squash was recovered from Late Woodland contexts at the Faucett site in eastern Pennsylvania. Kinsey cites a 1973 manuscript by Moeller for this information. Moeller (1975b, 1991, 1992:98, personal communication 2007) has stated that there is no squash from Faucett. Kinsey (1972:256) also implies in a summary statement that maize, bean, and squash were important at the Kutay site in eastern Pennsylvania. No evidence for these crops is presented in the body of the report. Moeller (personal communication 2007) does not remember seeing anything but a few corn kernels from Kutay and noted that flotation was not employed to recover seeds. The author contacted Kinsey to see if there were any actual evidence for squash at Faucett and for bean and squash at Kutay. Kinsey (personal communication 2007) stated that “Kutay is certainly a generalized statement, based upon an assumption that it was present but I doubt that we had direct evidence. Probably, the same applies to Faucett.” Thus, squash is not listed as present at Faucett and bean and squash are not listed for Kutay in the accompanying tables.

All cucurbit specimens from western Pennsylvania have been dated only by associated charcoal samples and cultural remains (Table 2-1). The earliest of these date to 3065±80 B.P. (cal. 2σ 1499–1057 B.C.), 2820±75 B.P. (cal. 2σ 1208–819 B.C.) and 2815±80 B.P. (cal. 2σ 1209–813 B.C.) at Meadowcroft Rockshelter (36WH297) (Adovasio et al.

1998; Cushman 1982:216). Six cucurbit rind fragments have also been recovered from Early Woodland contexts at Mayview Bend (36AL125) (Raymer and Bonhage-Freund 1998:26). A squash rind fragment was recovered from the Billy #3 (36WM717), a Middle Woodland Fairchance Phase (ca. A.D. 50–450) site (George 1992:17). There are no associated radiocarbon dates with the Billy #3 sample, but the site is believed to have been occupied between ca. 100 B.C. and A.D. 400 (George 1992:32).

Bottle gourd seeds (*Lagenaria siceraria*) were also recovered from Sheep Rock Shelter (Bebrich 1967). The bottle gourd seeds were recovered from the upper levels of the shelter and probably were from one or more of the Late Woodland or Late Prehistoric occupations. However, it would be beneficial to have some of the *Lagenaria* from Sheep Rockshelter Master Level 3 AMS dated because bottle gourd has been recovered from early contexts elsewhere in the United States (e.g., Doran et al. 1990).

It is highly recommended that all cucurbit remains from pre-Late Woodland/Late Prehistoric contexts (i.e., any site reported to be older than ca. A.D. 1000) in Pennsylvania be directly AMS dated to confirm their early use. At Meadowcroft Rockshelter, Mayview Bend, and Catawissa Stratum III, later components are present that might have contributed these samples and contaminated those levels. This does not mean such contamination occurred, only that direct AMS dates would provide conclusive evidence for the age of these and any other domesticates found at sites.

Tobacco

Tobacco (*Nicotiana rustica*) may be another early cultigen grown in the region. However, all evidence for its early use is indirect and based on the presence of smoking pipes at Cresap Phase sites dating after ca. 500 B.C. (McConaughy n.d.). Conversely, ethnographic records from the region indicate the Native Americans smoked many other plants besides tobacco, and the pipes may only demonstrate they were using these plants (Rafferty 2002:906). Nevertheless, there is some tantalizing evidence that tobacco was present by the Early Woodland Period. Nicotine was identified using gas chromatography/mass spectroscopy on residue from an Early Woodland pipe recovered from Cresap Mound (Rafferty 2002). This suggests that tobacco was smoked during the Early Woodland Period. However, there are a few other native plants that do contain the alkaloid needed to produce nicotine residue. Milkweed (*Asclepias* spp.) and False Daisy (*Eclipta* spp.) are two such native plants (Rafferty 2002:906). Even so, there is no ethnographic evidence that these plants were smoked by Native Americans. Tobacco is the only plant smoked by historic Native Americans that would produce nicotine residue. Thus, the planting and use of tobacco is likely during the

Table 2-2: Tobacco (*Nicotiana* sp.) remains from Pennsylvania

Site	AMS/Associated charcoal	Sample No.	Radiocarbon Years	Cal. 2 σ	Reference
Memorial Park 36CN164	Charcoal	-	unassigned feature, site has various Clemson Island and Stewart Phase occupations dating from 1190 \pm 40 to 420 \pm 40.		Hart and Asch Sidell 1996:7–26
Brant 36IN362	AMS date on bean	Beta-201662	600 \pm 40	A.D. 1294–1411	Neusius and Chiarulli 2007; Ramsey and Wymer 2004

Early Woodland Period in Pennsylvania, but not confirmed.

The use of smoking pipes continues through the early Middle Woodland Period when Hopewell platform pipes are utilized. However, after the demise of Hopewell and prior to the development of Late Prehistoric groups, there is little evidence for ceramic or stone pipe use during the late Middle to early Late Woodland Period (ca. A.D. 400 to 1000) in Pennsylvania. Presumably these peoples did not abandon smoking, but used more perishable materials, such as wood, for pipes, or rolled leaves of their smoking mixture into cigar-like forms for use. Conversely, the number of excavated sites from this time period is small. It is possible that pipes were used but simply not recovered due to limited work. Nevertheless, at this time there is little direct evidence for the use of smoking materials between ca. A.D. 400 and 1000 in Pennsylvania. It is not until after approximately A.D. 1000 that various styles of ceramic elbow pipes can be confirmed from sites in Pennsylvania.

Actual remains of tobacco are limited to Late Prehistoric times (Table 2-2). Excavations and extensive flotation at the Memorial Park and Brant sites yielded a few tobacco seeds (Hart and Asch Sidell 1996:7–26; Ramsey and Wymer 2004). Unfortunately, the single Memorial Park seed came from a feature that did not yield any diagnostic materials. It could date from either Clemson Island or Stewart Phase contexts that run from Late Woodland to Late Prehistoric times in northern Pennsylvania. The Brant specimens date to ca. A.D. 1200 based on an associated AMS date on a bean and other samples from the site (Neusius and Chiarulli 2007).

Chenopod

Only three sites from Pennsylvania have produced samples potentially identified as domesticated *Chenopodium berlandieri* (Table 2-3). One thin testa *Chenopodium* cf. *berlandieri* seed was recovered from a Middle Woodland feature at the Barking Road site from southwestern Pennsylvania (Long 1992:15–16, Table 8). However, wild

stands of *Chenopodium* occasionally produce seeds that cannot be distinguished from domesticated forms (Smith 1992b:149). The sample of one seed from Barking Road along with others identified only as *Chenopodium* sp. may only indicate use of a wild chenopod. Thin testa specimens of *Chenopodium berlandieri* ssp. *jonesianum* along with specimens that resemble the Mexican cultigen huauzontle were also recovered from the Memorial Park site (Hart and Asch Sidell 1996:17). These specimens indicate domesticated *Chenopodium* was present in Pennsylvania by late Middle or early Late Woodland times. The *Chenopodium* cf. *berlandieri* recovered from McJunkin is associated with the Late Prehistoric Monongahela tradition (King 1999:17).

One other chenopod seed recovered from the Dunsfort site may be of domesticated *Chenopodium berlandieri*. King (2004:37) lists a *Chenopodium* ssp. in Table 2-3 from her report of plant remains from Dunsfort. However, in the text she identifies it as *Chenopodium berlandieri* ssp. *jonesianum* (King 2004:38). Unfortunately, the discrepancy between the table and text comments cannot now be clarified by King. This author is going to err on the side of caution and conclude that the table identification as *Chenopodium* sp. is correct and that King inadvertently wrote it was the domesticated chenopod.

Specimens of wild *Chenopodium* are much more common (Table 2-3) and have been recovered from Early and/or Middle Woodland contexts at Meadowcroft Rockshelter (Cushman 1982:214–218); Mayview Depot (Raymer and Bonhage-Freund 1998), Mayview Bend (Raymer and Bonhage-Freund 1998); Crawford-Grist Site #2 (Grantz 1986:17), Barking Road (Long 1992:15–16, Table 8); and Watson Farm (46HK34, Ericksen and McConaughy 2002) in the northern panhandle of West Virginia and western Pennsylvania. Wild *Chenopodium* spp. has also been recovered from Early to Middle Woodland contexts in north central and eastern Pennsylvania at Bloomsburg Bridge, Catawissa Stratum III, and Smithfield Beach. However, most of the chenopod remains from north central and eastern Pennsylvania

Table 2-3: Specimens of chenopod (*Chenopodium* spp.) from Pennsylvania and the northern West Virginia panhandle.

Scientific binomial	Common Name	Site	Dated Material	Lab Number	Radiocarbon Age (B.P.)	Cal. 2σ Range (B.C./A.D.)	Source
<i>Chenopodium berlandieri</i>	Domesticated <i>Chenopodium</i>	Barking Road 36AL313	Charcoal		5 dates ranging from 1830±90 to 1500±60	16 B.C.– A.D. 407 to A.D. 431–647	Long 1992:8, 15–16, Table 8; Kingsley et. al. 1994:14–42
<i>Chenopodium berlandieri</i>	Domesticated <i>Chenopodium</i>	Memorial Park 36CN164	Charcoal	Pitt-1073, Pitt-1075, Beta-46542, Beta 46545	pooled mean of 4 dates 1161±27	A.D.778–967	Hart and Asch Sidell 1996:7–17
<i>Chenopodium berlandieri</i>	Domesticated <i>Chenopodium</i>	McJunkin Site 36AL17	Charcoal	UGa-1525 UGa-1524	660±95 570±65	A.D. 1186–1440 A.D. 1290–1438	King 1999:17; Herbstritt 1988:5
<i>Chenopodium</i> sp.	Chenopod	Mayview Depot 36AL124	Charcoal	Beta-92731	3030±80	1445–1029 B.C.	Raymer and 1-D; Bonhage-Freund 1998:13, Apendix Kellogg et. al. 1998:Table 2
<i>Chenopodium</i> sp.	Chenopod	Meadowcroft Rockshelter 36WH297	Charcoal	SI-2066	2930±75	1375–928 B.C.	Cushman 1982:214–218
<i>Chenopodium</i> sp.	Chenopod	Mayview Bend 36WH125	Charcoal	Beta-96484 to Beta-96496	12 C14 dates ranging from 2990±80 to 2160±70	1419–1005 B.C. to 383–46 B.C.	Raymer and Bonhage-Freund 1998:32, Appendix D: Kellogg et. al. 1998:Table 5
<i>Chenopodium</i> sp.	Chenopod	Mayview Depot 36AL124	Charcoal	Beta-92731	2440±60	761–403 B.C.	Raymer and Bonhage-Freund 1998:13, Apendix 1-D; Kellogg et. al. 1998:Table 2
<i>Chenopodium</i> sp.	Chenopod	Crawford-Grist Site #2 36FA262	Charcoal	DIC-3105 and DIC-3061A	two C14 dates ranging from 2430±55. to 2370±150	756–401 B.C. . to 808–97 B.C	Grantz 1986:17–18
<i>Chenopodium</i> sp.	Chenopod	Bloomsburg Bridge (36CO10)	from un-dated features two cultural components dated by 3 radiocarbon dates	Beta-24487 to Beta-24496 and Beta 25370	2380±60. to 2130±60 and 1480±70	756–373 B.C. to 364–3 B.C. and A.D. 428–660	Hay 1989; Wyatt 2003:39–40
<i>Chenopodium</i> sp.	Chenopod	Meadowcroft Rockshelter 36WH297	Charcoal	SI-2051	2290±90	749–106 B.C.	Cushman 1982:214–218
<i>Chenopodium</i> sp.	Chenopod	Barking Road 36AL313	Charcoal		5 dates ranging from 1830±90 to 1500±60	16 B.C. – A.D. 407 to A.D. 431–647	Kingsley et. al. 1994:14–42; Long 1992:8, 15–16, Fischler and French 1991:150–151
<i>Chenopodium</i> sp.	Chenopod	Smithfield Beach 36MR5	Associated “Terminal” Middle Woodland artifacts		estimated to date between 1850 and 1050		
<i>Chenopodium</i> sp.	Chenopod	Dunsfort 36WH477	Charcoal	B-55772	1420±70	A.D. 435–769	George 2004c:25, King 2004:37
<i>Chenopodium</i> sp.	Chenopod	Catawissa Str. III 36CO9	?	Pitt-8 , Pitt-76, Pitt-11	three C14 dates ranging from 1455±45 to 1280±35	A.D. 470–663 to A.D. 658–856	Herbstritt1988:10; King 1999:20

continues

Table 2-3: Specimens of chenopod (*Chenopodium* spp.) from Pennsylvania and the northern West Virginia panhandle. *Continued*

<i>Scientific binomial</i>	<i>Common Name</i>	<i>Site</i>	<i>Dated Material</i>	<i>Lab Number</i>	<i>Radiocarbon Age (B.P.)</i>	<i>Cal. 2σ Range (B.C./A.D.)</i>	<i>Source</i>
<i>Chenopodium</i> sp.	Chenopod	Watson Farm 46HK34			Middle/Late Woodland c. 1450 B.P. (A.D. 500)		Ericksen and McConaughy 2002
<i>Chenopodium</i> sp.	Chenopod	Catawissa Str. IV 36CO9	?	Pitt-12, DIC-3151, Pitt-74 and Pitt-77	four C14 dates ranging from 1040±45. to 795±75	A.D. 470–663 to A.D. 658–856	Herbstritt1988: 10; King 1999:20
<i>Chenopodium</i> sp.	Chenopod	West Water Street 36CN175	Associated charcoal	Beta-53663	850±60	A.D. 1040–1271	Custer et al. 1994:14–23; Hart and Asch Sidell 1996:25
<i>Chenopodium</i> sp.	Chenopod	Brant 36IN362	AMS date on bean	Beta-201662	600±40	A.D. 1294–1411	Neusius, and Chiarulli 2007; Ramsey and Wymer 2004
<i>Chenopodium</i> sp.	Chenopod	Fisher Farm 36CE35	Charcoal	UGa-2276	600±105	A.D. 1212–1616	Hart and Asch Sidell 1996:25; King 1999:19; Willey 1980:138
<i>Chenopodium</i> sp.	Chenopod	Faucett 36PI13A	Charcoal	Y-2474 and Y2473	640±120 540±100	A.D. 1050–1613 A.D. 1270–1630	Custer 1996:296; Moeller 1975a, 1975b, 1991, 1992

come from Late Woodland to Late Prehistoric levels at Catawissa Stratum IV, West Water Street, Fisher Farm, and Faucett. These data suggest that wild chenopods were an important food resource used by the Woodland inhabitants of the region and propagation of wild chenopods may have been encouraged by them.

Polygonum erectum and Polygonum spp.

The Dunsfort site was an important late Middle to early Late Woodland black walnut processing station (George 2004c; King 2004:35). However, it also produced some of the best evidence for the early use of Eastern Agricultural Complex plants from western Pennsylvania. King (1999:14; 2004) indicates that 60% of the seeds from the Dunsfort site in southwestern Pennsylvania were Eastern Agricultural Complex remains. Erect knotweed (*Polygonum erectum*) was recovered from four of seven features whose ethnobotanical remains were analyzed (King 2004:37) (Table 2-4).

King (2004:38) considered the erect knotweed from Dunsfort to be a quasi-cultigen. Historic specimens of *Polygonum erectum* were found across the region based on USDA Natural Resources Conservation Service range maps found at: <http://plants.usda.gov/java/profile?symbol=POER2>. Thus, erect knotweed cannot be assumed to be a fully domesticated plant when recovered from local archaeological contexts without evidence of increased seed sizes or some other traits not found in wild specimens.

Examples of wild knotweed or smartweed (identified only as *Polygonum* spp.) have been recovered from Early and Middle Woodland contexts at six western Pennsylvania sites (Table 2-4). *Polygonum* spp. has also been recovered from Late Woodland levels at one central and one eastern Pennsylvania site (Table 2-4). These data suggest that *Polygonum* was an important supplement to the diets of Pennsylvania groups during Woodland times, even if it was not domesticated.

Little Barley

Little barley (*Hordeum pusillum*) is increasingly being recognized as an important starchy seed utilized by prehistoric groups across the Midwest (King 1999:12). King (2004:38) considers it an important quasi-cultigen. Historic samples of little barley were recovered only from Bedford (southern) and Bucks (southeastern) counties in Pennsylvania according to USDA Natural Resources Conservation Service range maps found at: <http://plants.usda.gov/java/profile?symbol=HOPU>. Thus, it is not a widely distributed wild plant and should be considered a potential prehistoric cultigen in Pennsylvania.

Little barley has been recovered from late Middle to early Late Woodland contexts at Watson Farm, from the northern panhandle of West Virginia, and stratum III at Catawissa in north central Pennsylvania (Table 2-5). Little barley has also been recovered from Late Woodland contexts at Memorial Park, where it was the most abundant

Table 2-4: *Polygonum erectum* and *Polygonum* spp. from Pennsylvania

<i>Scientific binomial</i>	<i>Common Name</i>	<i>Site</i>	<i>Dated Material</i>	<i>Lab Number</i>	<i>Radiocarbon Age (B.P.)</i>	<i>Cal. 2σ Range (B.C./A.D.)</i>	<i>Source</i>
<i>Polygonum erectum</i>	Erect	Dunsfort	Charcoal	Beta-55772	1420±70	A.D. 435–769	George 2004c:25, King 2004:37
<i>Polygonum</i> sp.	Knotweed	36WH477	Charcoal	Beta-92731	3030±80	1448–1029 B.C.	Kellogg et. al. 1998:Table 2; Raymer and Bonhage-Freund 1998:13, Appendix 1-D
		Mayview Depot 36AL124					Adovasio, et al., 1998; Cushman 1982:217
<i>Polygonum</i> sp.	Knotweed	Meadowcroft Rockshelter 36WH297	Charcoal	SI-2066	2930±75	1375–928 B.C.	
<i>Polygonum</i> sp.	Knotweed	36WM610	Charcoal	DIC-3020 to DIC-3024	4 C14 dates ranging from 2960±55 to 2370±55	1374–1013 B.C. to 753–264 B.C.	Ballweber 1989:89-90
<i>Polygonum</i> sp.	Knotweed	Barking Road 36AL313	Charcoal		5 dates ranging from 1830±90 to 1500±60	16 B.C. –A.D. 407 to A.D. 413–647	Kingsley et. al. 1994:14–42; Long 1992:8, 15-16, Table 8; Ballweber 1989:68 –70; George 1992:29, 32
<i>Polygonum</i> sp.	Knotweed	Backstrum #1 36WM453	Charcoal	DIC-3028 DIC-3059	1490±60 1260±50	A.D. 432–651 A.D. 665–878	
<i>Polygonum</i> sp.	Knotweed	Mayview Bend 36AL125	Charcoal	Pooled dates, Beta-96537 and Beta-96538	1250±44	A.D. 672–878	Kellogg et. al. 1998:Table 5; Raymer and Bonhage-Freund 1998:32, Appendix D; Custer 1996:296; Kinsey 1975: 17; Moeller 1975a, 1975b, 1991, 1992
<i>Polygonum</i> sp.	Knotweed and Smartweed	Faucett 36PI13A	Charcoal	Y-2474 Y2473	640±120 540±100	A.D. 1050–1613 A.D. 571–1630	King 1999:19; Willey 1980:138
<i>Polygonum</i> sp.	Knotweed	Fisher Farm 36CE35	Charcoal	UGa-2276	600±105	A.D. 1212–1616	

seed recovered (n=336, Hart and Asch Sidell 1996:15), and in stratum IV from Catawissa (Table 2-5).

Little barley may also have been recovered from late Middle to early Late Woodland contexts at the Dunsfort site from southwestern Pennsylvania. King (2004:38) indicates it was recovered in the text portion of the Dunsfort report, but it is not listed in her table 3 compendium of plant remains (King 2004:37). King probably was just listing things out of habit that were commonly found at sites she was analyzing. Unfortunately, King apparently did not get the chance to review her draft report for Dunsfort prior to her death and did not catch this error prior to its submission for publication. Conversely, King (1999:14) clearly states that “no remains of squash, *little barley*, or sunflower were recovered from the Dunsfort site” (emphasis added). Based on this quote, the author believes the claim of little barley in the text from the

Dunsfort report is erroneous. Thus, it is not listed with the other sites in Table 2-5.

Current data from Pennsylvania sites do not support the widespread use of this plant during the Middle and Late Woodland periods. Nevertheless, it was exploited by some of these inhabitants and it may prove to be a more important potential domesticated in the state as more sites have flotation samples analyzed.

Maygrass

Maygrass (*Phalaris caroliniana*) is another Eastern Agriculture quasi-cultigen that appears at Pennsylvania sites dating to the Early to early Late Woodland periods. However, this starchy seed plant is not a commonly recovered plant in Pennsylvania and is reported from only three sites (Table 2-6). The United States Department of Agriculture does not list any historic specimens of

Table 2-5: Specimens of little barley (*Hordeum pusillum*) recovered from Pennsylvania sites

Site	Material Dated	Lab Number	Radiocarbon Age (B.P.)	Cal. 2σ Range (A.D.)	Source
Catawissa Str. III 36CO9	Charcoal?	Pitt-8, Pitt-76, Pitt-11	Three dates ranging from 1455±45 to 1280±35 Middle/Late Woodland c. 1450	470–663 to 658–856	Hart and Asch Sidell 1996:25; Herbstritt 1988:10; King 1999:20
Watson Farm 46HK34 Catawissa Str. IV 36CO9	Charcoal	Pitt-12, DIC-3151, Pitt-74 and Pitt-77	Four dates ranging from 1040±45 to 795±75	891–1148 to 1040–1368	Ericksen and McConaughy 2002. Hart and Asch Sidell 1996:25; Herbstritt 1988:10; King 1999:20
Memorial Park 36CN164	Charcoal	Pitt-1073, , Pitt-1075, Beta-46542 Beta 46545	Pooled mean of 4 dates 1161±27 (also in later samples from site)	778–967	Hart and Asch Sidell 1996:7-17

Table 2-6: Maygrass (*Phalaris caroliniana*) remains from Pennsylvania

Site	Material Dated	Lab Number	Radiocarbon Age (B.P.)	Cal. 2σ Range (B.C./A.D.)	Source
Mayview Depot 36AL124	Charcoal	Beta-92731 to Beta-92733	4 C14 dates ranging from 3030±80 to 1640±90	1448–1029 B.C. to A.D. 178–610	Kellogg et. al. 1998:Table 2; Raymer and Bonhage-Freund 1998:13, Appendix 1-D
Mayview Bend 36AL125	Charcoal	Beta-96496	2160±70	382–46 B.C.	Kellogg et. al. 1998:Table 5; Raymer and Bonhage-Freund 1998:32, Appendix D
Dunsfort 36WH477	Charcoal	B-55772	1420±70	A.D. 435–769	George 2004c:25, King 2004:37

Table 2-7: Remains of marshelder (*Iva annua*) from Pennsylvania and the northern panhandle of West Virginia

Site	Material Dated	Lab Number	Radiocarbon Age (B.P.)	Cal. 2σ Range (B.C./A.D.)	Source
Dunsfort 36WH477 Watson Farm 36WH477	Charcoal	B-55772	1420±70 Middle/Late Woodland ca. A.D. 500	A.D. 435–769	George 2004c:25, King 2004:37 Ericksen and McConaughy 2002

maygrass from Pennsylvania or West Virginia at: <http://plants.usda.gov/java/nameSearch>. Thus, it is presumed any maygrass remains recovered in Pennsylvania are outside of their normal range and probably represent a plant propagated by local inhabitants.

Iva annua

Marshelder or sumpweed (*Iva annua*) is not commonly found on sites from the region. However, two late Middle to early Late Woodland sites have produced small samples of this species (Table 2-7). A total of five seeds were recovered from one feature at the Dunsfort site from southwestern Pennsylvania (King 2004:37). A single seed was recovered from each of two features (2 seeds total) from the Watson Farm site in the northern panhandle of West Virginia (Ericksen and McConaughy 2002).

Historic examples of wild *Iva annua* from the region are

rare. *Iva annua* is listed as being found only in Blair County in central Pennsylvania on USDA Natural Resources Conservation Service range maps found at: <http://plants.usda.gov/java/profile?symbol=IVAN2>. This suggests specimens recovered from archaeological sites from the northern panhandle of West Virginia and Pennsylvania represent examples found largely outside of the normal range for the wild species. Also, the five seeds from Dunsfort are larger than modern wild specimens (King 2004:38). Thus, the *Iva annua* from the region likely represents a cultivated species, although not one that was commonly exploited in the region.

Sunflower

Sunflower (*Helianthus annuus*) apparently is the latest native cultigen to appear in Pennsylvania and vicinity (Table 2-8). There is no direct evidence from the area for

Table 2-8: Sites producing sunflower (*Helianthus annuus*) remains from Pennsylvania

Site	Material Dated	Lab Number	Radiocarbon Age (B.P.)	Cal. 2 σ Range (A.D.)	Source
Memorial Park 36CN164	Assoc. C14	Beta-46542 Beta-46548	1140 \pm 60 1020 \pm 50	772–1018 895–1155	Hart and Asch Sidell 1996:7, 26
Railroad site 36SO113	Assoc. C14	20 dates?	1150 \pm 50 510 \pm 50	724–994 1305–1463	Means 2002:287–293
Pony Farm Triangle East 36SO243	Assoc. C14	B97737	770 \pm 60	1054–1386	Means 2002:288–292
Jonas Field 36SO241	Assoc. C14	B85305, B113955, B85304 and B101492	Four dates ranging from 780 \pm 60.to 590 \pm 60	1189–1283 to 1287–1428	Means 2002:288–294
Gnagey No. 3 36SO55	Assoc. AMS date on bean and 4 AMS dates on maize	AA53306, AA53307, AA53308, AA53310 and AA53311	Five dates ranging from 713 \pm 34to 202 \pm 33	1228–1386 to 1644–1952	Means 2002:292; 2005:55
McJunkin Site 36AL17	Assoc. C14	UGa-1525 UGa-1524	660 \pm 95 570 \pm 65	1186–1440 1290–1438	King 1999:14–16; George 1978
Fisher Farm 36CE35	Assoc. C14	UGa-2276	600 \pm 105	1212–1616	Hart and Asch Sidell 1996:25; King 1999:19; Willey 1980:137
Sony Site 36WM151			protohistoric village ca. 450 B.P		Davis and Wilks 1997; King 1999:14-16
Sheep Rockshelter	charcoal	M-2086, M-1904, M-2084, M-1905, and M-1903	five dates ranging from 500 \pm 100 to 260 \pm 100	1285–1634 to 1449–1953	Berbich 1967; Herbstritt 1988:12

the use of domesticated sunflower prior to the late Late Woodland Period. However, there is a sample of four composite seeds from Middle Woodland contexts at Fairchance mound and village in the northern panhandle of West Virginia that may be from a wild form of sunflower (Cutler and Blake 1984:66).

The earliest domesticated sunflower from Pennsylvania was recovered from the Memorial Park site in northeastern Pennsylvania in a Clemson Island feature dated to ca. A.D. 810 (Hart and Asch Sidell 1996; King 1999:19) (Table 2-8). This date suggests it was used during the Late Woodland period in Pennsylvania.

Sunflower also appears on several Monongahela sites during the Late Prehistoric Period from western Pennsylvania (Table 2-8). Sunflower has been recovered from the Pony Farm Triangle East, Railroad, Jonas Field, Gnagey No. 3, McJunkin, and Sony sites (King 1999:14–16; Means 2002:292–294). Special note should be made of the dates listed for Gnagey No. 3 in Table 2-7. The two occupations at Gnagey No. 3 were originally dated using charcoal samples to between radiocarbon A.D. 920 and 1030 and A.D. 1085 and 1190 by George (1983). Redating of the components using AMS assays on maize and one bean indicate the original dates were too old. The older Gnagey No. 3 village dates to the thirteenth century A.D., while the younger dates to the fourteenth century A.D. (Means 2002:292; 2005). Sunflower has also been recovered from Late Woodland to Late Prehistoric con-

texts at Fisher Farm and Sheep Rockshelter in central Pennsylvania. None of the sunflower remains were directly AMS dated. In any case, it appears that sunflower is a relatively late addition to the crops grown by the prehistoric inhabitants of Pennsylvania.

Maize

The actual date when maize horticulture was introduced into Pennsylvania is still not adequately determined. Currently, the oldest direct AMS radiocarbon dates on maize from the eastern United States are 2077 \pm 70 B.P. (cal. 2 σ 355 B.C. –A.D. 69) and 2017 \pm 50 B.P. (cal. 2 σ 166 B.C. –A.D. 75) from the Holding Site in Illinois (Riley et al. 1994:493–494). There also are direct AMS radiocarbon dates on maize of 1775 \pm 100 B.P. (cal. 2 σ A.D. 25–532) from Icehouse Bottom, Tennessee (Chapman and Crites 1997) and 1730 \pm 85 B.P. (cal. 2 σ A.D. 89–534) and 1720 \pm 105 B.P. (cal. 2 σ A.D. 78–547) from the Edward Harness site, Ohio (Ford 1987; Riley et al. 1994:495). These dates show that it is at least possible for maize horticulture to have been introduced into Pennsylvania by Middle Woodland or early Late Woodland times.

A maize cob fragment was recovered from Early Woodland Cresap Phase contexts at Meadowcroft Rockshelter in western Pennsylvania (Table 2-9). The cob fragment was identified as 16 row popcorn by Cutler and Blake (Cushman 1982:216). The maize was dated by associated charcoal assays to 2325 \pm 75 B.P. (cal. 2 σ 751–198

B.C.) and 2290±90 B.P. (cal. 2σ 749–106 B.C.) (Cushman 1982:216). These dates would make it the oldest macrofloral maize recovered from the Eastern United States if accepted at face value. However, there are examples of maize from apparently undisturbed “early” contexts that have been directly AMS radiocarbon dated to much later periods (Conard et al. 1984). The midwestern examples demonstrate that maize, seeds, and other plant remains can migrate into older contexts through undetected bioturbation. The associated Meadowcroft charcoal dates should not be uncritically accepted as dating the maize. The Meadowcroft assays adequately date the associated Cresap phase lithic and ceramic remains, but may not accurately date the maize. The early maize from Meadowcroft *must* be AMS dated to confirm the associated dates actually are applicable to the cob. Otherwise, it should be considered to be a later contaminant until proven to be early.

Nevertheless, it is interesting that the alleged early Meadowcroft maize was from a 16 row popcorn and not from 8 row Northern Flint. Northern Flint is the most common form of maize recovered from Late Prehistoric sites in the region (Kraft 2001:280). Microfloral remains also suggest that maize may have been present in the eastern United States long before the dated macrofloral maize remains indicate. Maize pollen from Lake Shelby, Alabama, has been dated by associated radiocarbon dates on bulk organic materials to ca. 3500 B.P., from Ft. Center, Florida, to ca. 2500 B.P. from B. L. Bigbee Lake, Mississippi, to ca. 2400 B.P. and from Dismal Swamp, Virginia to ca. 2200 B.P. (Fearn and Liu 1995:111). These dates suggest that maize may have entered the eastern United States during the Late Archaic or Early Woodland Periods. However, these samples are also open to the same criticisms as macrofloral maize remains. The radiocarbon dates were not run on the actual maize pollen to confirm the age of the remains. Unfortunately, it is unlikely the pollen samples are of sufficient size for even AMS dates to be run on them. It is possible that the pollen migrated down the columns at the respective sites through various methods including bioturbation and water action.

More recently, Hart et al. (2003, 2007), Hart and Brumbach (2005), and Thompson et al. (2004) have examined charred residues found in samples of pottery from New York for phytolith evidence that could be used to interpret what was cooked in the pots. These studies have found phytoliths consistent with those produced by maize on ceramics dating to the Early Woodland period. The oldest sample is from a Sherd recovered from the Vinette site, New York that dated to 2270±35 B.P. (cal. 2σ 399–208 B.C.; Hart et al. 2007:Table 2-1 and 2-6). It is as old as the associated dates for the maize from Meadowcroft.

There are other possible early maize remains from western Pennsylvania dated by associated charcoal remains. A single maize kernel was recovered from the Early Woodland Thorpe site, and a radiocarbon date from the site was 1900±60 B.P. (cal. 2σ 38 B.C.–A.D. 242; A.D. 50; King 1998:20, George 1998:21). Two maize cupules were identified in flotation samples from Feature 1 at Backstrum #1 (36WM453) and radiocarbon dates obtained from other areas at Backstrum #1 were 1490±60 B.P. (cal. 2σ A.D. 432–651) and 1260±50 B.P. (cal. 2σ A.D. 665–878; George 1992:29, 32). In addition, three maize cupules were recovered from early Late Woodland Watson features at the Watson Farm site (Ericksen and McConaughy 2002). The associated Watson remains should date to ca. 1450 B.P. (A.D. 500). However, there is at least one, and possibly several, Late Prehistoric occupations at Watson Farm located in a different area than Watson component (McConaughy 2000, 2002). Nevertheless, Late Prehistoric inhabitants may have grown maize where the Watson component was located. Maize has also been reported from pre-ca. 1100 B.P. contexts, based on associated charcoal dates, in north central Pennsylvania at Fisher Farm (Willey 1980:137; King 1999:19; Hart and Asch Sidell 1996:24) and Catawissa stratum III (King 1999:20). It is recommended that all of these maize samples be considered later contaminants until the maize samples are directly AMS assayed to confirm the early dates ascribed to them.

There is one other indirect piece of evidence that suggests maize may have been present in the region by Middle Woodland times. Burial 14 from the Middle Woodland Fairchance Mound had a δ¹³C of -12.7‰ suggesting her diet might have been composed of at least 50% C4 pathway plants (Hemmings 1984:18). It suggests she was eating maize because maize is the only C4 pathway plant likely to have been eaten in the eastern United States. If the δ¹³C measurement for Burial 14 was correct, and Hemmings does recommend it be reexamined, then only one individual from the mound produced elevated δ¹³C levels. It would indicate societal members had differential access to maize at Fairchance. Burial 14 was one of the central burials in Fairchance Mound, and along with its differential access to maize, suggests that significant status differences existed within the Fairchance population. However, there are other possible explanations for the elevated δ¹³C level. High concentrations of marine shellfish in the early diet of an individual can also produce elevated δ¹³C levels. There was an extensive trade in whelks and other marine materials around the eastern United States during Hopewell times. It is possible that the female in Burial 14 was not originally from the West Virginia area. A coastal woman may have married one of the Hopewellian traders and returned to West Virginia to live. Reanalysis of these remains using recently devel-

Table 2-9: Maize (*Zea mays* ssp. *mays*) remains from Pennsylvania and vicinity.

AMS or other directly assayed maize radiocarbon dates from Pennsylvania					
Site	Material	Sample No.	Radiocarbon Age (B.P.)	Cal. 2 σ Sigma Range (B.C./A.D.)	Reference
Memorial Park 36CN164	Maize cupule	AA-19127	985 \pm 45	A.D. 979–1162	Hart and Asch Sidell 1996:7–9
Campbell Farm 36FA26	Maize	AA-40133	794 \pm 38	A.D. 1175–1279	Hart et al. 2002:381
Gnagey No. 3, Village 1 36SO55	Maize kernel	AA53310	692 \pm 46	A.D. 1228–1395	Means 2005:55
Saddle 46MR95	Maize	AA-38458	605 \pm 34	A.D. 1296–1407	Hart et al. 2002:381
Gnagey No. 3, Village 2 36SO55	Maize kernel	AA53311	590 \pm 50	A.D. 1291–1422	Means 2005:55
Drew 36AL62	Maize	M-2198	590 \pm 100	A.D. 1219–1610	Buker 2004:23
Memorial Park 36CN164	Maize cupule	AA-19126	429 \pm 40	A.D. 1414–1625	Hart and Asch Sidell 1996:7–11
Peck No. 2-2 36SO8	Maize cob	AA53309	364 \pm 44	A.D. 1448–1635	Means 2005:55
Gnagey No. 3, Village 2 36SO55	Maize cob	AA53308	246 \pm 33	A.D. 1552–1951	Means 2005:55
Gnagey No. 3, Village 2 36SO55	Maize cob	AA53307	202 \pm 33	A.D. 1664–1952	Means 2005:55
Sites with Maize, dated components associated with maize remains					
Meadowcroft Rockshelter 36WH297	Charcoal	SI-1634 SI-2051	2325 \pm 75 to 2290 \pm 90	751–198 B.C. 749–106 B.C.	Adovaiso and Johnson 1981; Cushman 1982:216; Herbstritt 1988:21
Thorpe site 36AL335	Charcoal	Beta-33947	1900 \pm 60	38 B.C.–A.D. 242	King 1998:20; George 1998:21
Backstrum #1 36WM453	Charcoal	DIC-3028 DIC-3059	1490 \pm 60 1260 \pm 50	A.D. 432–651 A.D. 665–878	Ballweber 1989:68–70 George 1992:29, 32;
Catawissa Str. III 36CO9	Charcoal	Pitt-8 , Pitt-76, Pitt-11	Three dates ranging from 1455 \pm 45 1280 \pm 35 1245 \pm 70	A.D. 470–663 A.D. 658–856	Herbstritt 1988:10; King 1999:20
Fisher Farm 36CE35	Charcoal	UGa-2683	1245 \pm 70	A.D. 655–960	Hart and Asch Sidell 1996:24; King 1999:19; Willey 1980:137
St. Anthony 36UN11	Charcoal	Beta-22696 to Beta-22866	15 dates on Late Woodland Com- ponents ranging from 1150 \pm 90 to 660 \pm 70	A.D. 676–1024 to A.D. 1228–1418	Hart and Asch Sidell 1996:25; Herbstritt 1988:19; Stewart 1988
Murphy's Old House 36AR129	Charcoal	Beta-78747	1080 \pm 70	A.D. 775–1151	George 2005:23
Bald Eagle/Salmon 36CN102	Charcoal	UGa-4754	1040 \pm 85 (and possibly as old as 1100 based on other material from site)	A,D, 779–1178	Hart and Asch Sidell 1996:25-26; Hay and Hamilton 1984; King 1999:19
Catawissa Str. IV 36CO9	Charcoal	Pitt-12, DIC-3151, Pitt-74 and Pitt-77	Four dates ranging from 1040 \pm 45 to 795 \pm 75	A.D. 891–1148 to 1040–1381	Herbstritt 1988:10; King 1999:20
Ryan 36WM23	Charcoal	I-16727, GaK-3729, I-16713, B-20777, B-142812	Five dates ranging from 980 \pm 80 to 600 \pm ?	A.D. 894–1218	Cutler and Blake 1973:60; George 1974:16–17, 2004b:68
West Water Street 36CN175	Charcoal	Beta-53663	850 \pm 60	A.D. 1040–1271	Custer et al. 1996:14-23
Coverts Crossing 36LR75	Charcoal	Beta-142247	840 \pm 50	A.D. 1044–1274	MacDonald and Cremeens 2002:24

continues

Table 2-9: Maize (*Zea mays* ssp. *mays*) remains from Pennsylvania and vicinity. *Continued*

Sites with Maize, dated components associated with maize remains,					
Site	Material	Sample No.	Radiocarbon Age (B.P.)	Cal. 2 σ Sigma Range (B.C./A.D.)	Reference
Wylie 3 36WH283	Charcoal	B-33183 to B-58690	Four dates ranging from 780 \pm 60 to 610 \pm 60	A.D. 1050–1383 to A.D. 1281–1420	George 2001; King 1990
Wylie 1 36WH274	Charcoal	UGa-1912	710 \pm 85	A.D. 1157–1418	Eisert 1981:27, 58
Faucett 36PI13A	Charcoal	Y-2474 Y2473	640 \pm 120 540 \pm 100	A.D. 1050–1613 A.D. 1270–1630	Custer 1996:296; Kinsey 1975:17; Moeller 1975a, 1975b, 1991, 1992 George 2004a:61
Wilkinson Site 36WM344	Bone collagen	I-6713	640 \pm 80	A.D. 1229–1434	Custer 1996:274–278
Nace 36LA36	Charcoal	OWU-144B, OWU-143E, OWU-142A, OWU-144A, and OWU-143d	five dates ranging from 640 \pm 165 to 230 \pm 175	A.D. 1030–1634 to A.D. 1437–1956	
McKees Rocks Village 36AL16	Charcoal	M-2201	620 \pm 100	A.D. 1209–1468	Buker 1968:9; Jones 1968; Herbstritt 1988:5
Brant 36IN362	AMS on??	Beta-201662	600 \pm 40	A.D. 1294–1411	Ramsey and Wymer 2004; Neusius and Chiarulli 2007
Fisher Farm 36CE35	Charcoal	UGa-2276	600 \pm 105	A.D. 1212–1616	King 1999:19; Willey 1980:137
Portman Site 36AL40	Assoc charcoal		560 \pm 50 530 \pm 90	A.D. 1298–1437 A.D. 1277–1624	Buker 1993:43–45
Kutay 36PI25	Assoc charcoal	Y-2338	550 \pm 80	A.D. 1276–1484	Herbstritt 1988:17; Moeller per. com.;
Murry Site 36LA183	charcoal	Y-2480	540 \pm 100	A.D. 1270–1630	Kinsey and Graybill 1971:11, 39
Sheep Rockshelter 36HU1	charcoal	M-2086, M-1904, M-2084, M-1905, and M-1903	five dates ranging from 500 \pm 100 to 260 \pm 100	A.D. 1285–1634 to A.D. 1449–1953	Berbich 1967; Herbstritt 1988:12
Quaker Hills Quarry 36LA1100	charcoal		Late Shenks Ferry, series of dates circa 450–400		McKnight 2006
Coverts Bridge 36LR228	charcoal	Beta-143915	380 \pm 50	A.D. 1441–1635	MacDonald and Cremeens 2002:35-36
Sites with maize dated by associated component					
Watson Farm 46HK34			Middle/Late Woodland c. 1450		Ericksen and McConaughy 2002, believed to be a Late Prehistoric contaminant George 1996:65
Winter Knuckles 36WM432			Probably Monongahela, ca. 950–450		
Piersol II (or Pearsall in Custer 1996) 36CH339			Minguannan–Late Woodland ca. 800		Custer 1996:289; Egan 1991; Hart and Cremeens 1991:106
Smithfield Beach 36MR5	Associated artifacts and dates from nearby sites		Appears between 700 and 600?		Fischler and French 1991:161

oped techniques could show whether the elevated $\delta^{13}\text{C}$ levels was due to maize or marine protein ingestion. It might also show that the original $\delta^{13}\text{C}$ measurement was simply erroneous. Nevertheless, Burial 14 from Fairchance Mound is an intriguing individual.

The evidence for early maize use in western Pennsylvania is equivocal. Nevertheless, it is still likely that maize was introduced to the area by at least the Late

Woodland Period, based on the directly AMS dated Middle Woodland maize specimens from the Midwest. Also, Late Prehistoric Monongahela villages from western Pennsylvania dating after ca. A.D. 900 to 1000 have all produced maize remains (King 1999:15–16). AMS dates directly obtained on maize samples from Somerset Plateau Monongahela sites by Means (2002, 2005) indicate it was present there during the Late Prehistoric period

(Table 2-9). Studies of $\delta^{13}\text{C}$ in burials from Monongahela populations have confirmed that they have highly elevated levels indicating maize formed from 50% to over 70% of their diets (Farrow 1986; Greenlee 2006; Sciuilli 1995; Sciuilli and Carlisle 1975).

Greenlee (2006) also studied Late Woodland (ca. A.D. 400–1000) burials from the Ohio Valley and found there was a distinct jump in $\delta^{13}\text{C}$ levels around A.D. 900. Only after that date did she find any evidence for extensive use of maize by the inhabitants of the region. These data suggest that maize may have been present in small quantities prior to ca. A.D. 900, but was not a major constituent of the local diet until after that date. However, none of the AMS dated maize samples from the Ohio Valley in western Pennsylvania (Table 2-9) are as old as the elevated $\delta^{13}\text{C}$ level data presented by Greenlee. There are two ways to interpret this fact. One way is to concede that the earliest maize from the region has not yet been AMS dated. The other is to question the dates associated with the human remains. The dating for most of the burials is based on associated charcoal samples, and suffers from the same problems as charcoal dates associated with actual maize remains. In other words, the associated radiocarbon samples may or may not accurately date the human remains, and the time when maize became an important dietary staple was later than ca. A.D. 900. The first option is the preferred explanation herein, but the second option cannot be totally ruled out.

Maize was also commonly recovered from Clemson Island and other Late Woodland to Late Prehistoric sites in central and eastern Pennsylvania (Table 2-9). It is relatively abundant and was an important staple for these groups.

Beans

Common bean (*Phaseolus vulgaris*) appears rather late in the archaeological record from Pennsylvania. Some of the earliest directly AMS dated beans come from the Gnagey No. 3 site in western Pennsylvania (Table 2-10). However, the beans recovered from the Gnagey No. 3 site have been stated to be even older in some publications based on associated calibrated radiocarbon dates of A.D. 920–1190±80 years (Blake and Cutler 1983:85, Table 2) [Note: uncorrected date was not published with this information]. Blake and Cutler (1983:84) also cited a calibrated date of A.D. 1020±80 for beans from Feature 13D at Gnagey No. 3. George (1983:23) does not list a calibrated date of A.D. 1020±80 years from Feature 13 in his report of the Gnagey excavations, but there is a calibrated date of A.D. 1030±80 years from Feature 151 (George 1983:9). There also are calibrated dates for the earliest two Monongahela village components that range from A.D. 920±80 years to A.D. 1190±65 years (George 1983:5). It is suspected that the A.D. 920 to 1190 range of dates cited by

Blake and Cutler as the appropriate age range for the beans from Gnagey No. 3 are based on these latter assays. Nevertheless, more recent AMS assays run on beans from Gnagey No. 3 demonstrate beans are much later in age than the cited associated dates. Hart and Scarry (1999:656; also see Means 2002:286) provide AMS dates on a bean from Feature 13D of 635±45 B.P. (cal. 2 σ A.D. 1282–1407) and on a bean from Feature 30 of 610±55 B.P. (cal. 2 σ A.D. 1284–1416). Means (2005) also ran an AMS date on a bean from Gnagey that was 703±34 B.P. (cal. 2 σ A.D. 1228–1386). Thus, it appears that beans did not appear at Gnagey until ca. cal. A.D. 1300.

There also are directly AMS dated bean remains from the Fleming (36IN26) and Saddle (46MR95) sites. The Fleming site bean was dated to 720±40 B.P. (cal. 2 σ A.D. 1221–1386, Beta-204023; Chiarulli, 2005, 2006; Neusius and Chiarulli 2007) and currently is the oldest radiocarbon age on bean from Pennsylvania. The Saddle site bean was dated to 675±33 B.P. (cal. 2 σ A.D. 1271–1391; Hart et al. 2002:381).

Beans were also found at Drew Phase Monongahela sites of Ryan (Cutler and Blake 1973:60) and Drew (Blake and Cutler 1983:85; Buker 1970) that generally date between ca. A.D. 1000 and 1300 (all also cited in King 1999:16–17) (Table 2-10). The contexts suggest beans may be present in Pennsylvania earlier than ca. A.D. 1300 at these sites, but none of these beans were directly AMS dated to confirm their actual ages. This needs to be done before it can be demonstrated that beans were utilized prior to ca. A.D. 1300 in the region. In any case, beans apparently are a relatively late addition to the crops grown by groups in western Pennsylvania.

Further east, beans were allegedly recovered from a feature at the Bald Eagle site with an associated date of 1040±85 B.P. (cal. 2 σ A.D. 779–1178; King 1999:19; Hay and Hamilton 1984). However, no beans were found in the reexamination of the Bald Eagle remains suggesting the identification of this sample as a bean was erroneous (Hart and Scarry 1999:655).

CONCLUSIONS

Horticulture has a long history in the eastern United States and Pennsylvania. Early horticulture revolved around Eastern Agricultural Complex crops. Gourd/squash, goosefoot, erect knotweed, little barley, maygrass, and marshelder apparently were under cultivation in Pennsylvania and the northern panhandle of West Virginia during the Woodland period. It remains to be determined just how important these crops were in the diet of various Woodland groups, and if they were the impetus for the development of settled village life during the late Late Woodland/Late Prehistoric (ca. A.D.

Table 2-10: Bean (*Phaseolus vulgaris*) remains from Pennsylvania

Site	Material Dated	Lab Number	Radiocarbon Age (B.P.)	Cal. 2σ Sigma Range (A.D.)	Reference
Fleming 36IN26	Bean	Beta-204023	720±40	1221–1386	Chiarulli 2005, 2006; Neusius and Chiarulli 2007 Means 2005:55
Gnagey No. 3, Village 1 36SO55	Bean	AA53306	713±34	1228–1386	
Portman 36AL40	Bean	AA-38456	682±33	1268–1390	Hart et. al. 2002:381 Church and McDaniel 1992; Hart et. al. 2002:381; King 1999:16
Saddle 46MR95	Bean	AA-38457	675±33	1271–1391	
Gnagey No. 3, Fea-13D 36SO55	Bean	AA-29118	635±45	1282–1403	Hart et al. 2002:378; Hart and Scarry 1999:656; Means 2002:286
Gnagey #3 Fea-30 36SO55	Bean	AA-29118	610±55	1284–1416	
Brant 36IN362	Bean	Beta-201662	600±40	1294–1411	Neusius and Chiarulli 2007; Ramsey and Wymer 2004 Hart et. al. 2002:381
Campbell Farm 36FA26	Bean	AA-40132	462±38	1403–1609	
Catawissa Str. IV 36CO9	Charcoal?	Pitt-12, DIC-3151, Pitt-74 and Pitt-77	4 dates ranging from 1040±45 to 795±75 1040±85 (and possibly as old as ca. 1100 based on other material from site)	891–1148 to 1040–1381 779–1178	Hart and Sidell 1996:25; Herbstritt 1988:10; King 1999:20 NOTE: Originally identified as a bean in Hay and Hamilton 1984 Hart and Scarry 1999:655 suggest this was a misidentification Hart and Scarry 1999:655
Bald Eagle/Salmon 36CN102	Charcoal	UGa-4754			
Nash 36CN17	Charcoal	I-7266, I-7265, I-7264	990±80 to 235±80	891–1216 to 1478–1953 (beans were supposedly with 11th century component 894–1218)	Cutler and Blake 1973:60; George 1974:16-17, 2004b:68
Ryan 36WM23	?	I-16727, GaK-3729, I-16713, B-20777, B-142812	5 C14 dates ranging from 980±80 to 600±?		
West Water Street 36CN175	Charcoal	Beta-53663	850±60	1040–1271	Custer et al. 1996:14–23; Hart and Asch Sidell 1996:25 Custer 1996:296; Kinsey 1975:17; Moeller 1975a, 1975b, 1991, 1993 Custer 1996:274-278
Faucett 36PI13A	Charcoal	Y-2474 Y2473	640±120 540±100	1050–1613 1270–1630	
Nace 36LA36	Charcoal	OWU-144B, OWU-143E, OWU-142A, OWU-144A and OWU-143d	five dates ranging from 640±165 to 230±175	1030–1634 to 1437–1956	
McKees Rocks Village 36AL16	Charcoal	M-2201	620±100	1209–1468	Buker 1968:9; Herbstritt 1988:5
Fisher Farm 36CE35	Charcoal	UGa-2276	600±105	1212v1616	Hart and Asch Sidell 1996:26 King 1999:19; Willey 1980:138 Buker 2004:23; Cutler and Blake 1973; King 1999:17 Kinsey and Graybill 1971:11, 39 Berbich 1967; Herbstritt 1988:12
Drew 36AL62	Maize	M-2198	590±100	1219–1610	
Murry Site 36LA183	charcoal	Y-2480	540±100	1285–1634 to 1449–1953	
Sheep Rockshelter 36HU1	charcoal	M-2086, M-1904, M-2084, M-1905, and M-1903	five dates ranging from 500±100 to 260±100		
Quaker Hills Quarry 36LA1100	charcoal		Late Shenks Ferry, series of dates circa 450–400		McKnight 2006

900–1500/European contact), as has been hypothesized. Tobacco may also have been grown for use in rituals conducted by Woodland peoples.

The paucity of excavated habitation sites dating from the Early, Middle, and early Late Woodland periods from the region makes any interpretations of cultural processes difficult. The settlement types and subsistence patterns of local Woodland groups remains to be determined across the region. Additional work at sites from these periods, along with extensive use of flotation to recover subsistence remains, needs to be conducted so the importance of these foods, subsistence practices, and their effect on cultural practices can be assessed.

Something happened around A.D. 900 that shifted subsistence practices away from Eastern Agricultural Complex crops toward intensive maize horticulture. It might have been the introduction of 8 row Northern Flint that provided the impetus for the change. Northern Flint was well adapted to the climate of the northeastern United States. It likely was a more productive and reliable maize crop (Crawford et al. 2006). Another possibility is the development and spread of hominy technology caused a shift to greater maize use. Processing maize into hominy unlocks nutrients in the kernel and adds another form of maize to the native diet (Myers 2006). However, the reason or reasons for the adoption of intensive maize horticulture and decrease in importance of native Eastern Agricultural Complex crops remain to be determined.

The development of a native horticultural tradition must have aided the development of intensive maize propagation in the Pennsylvania during the late Late Woodland/Late Prehistoric period. Evidence of extensive maize use at Late Prehistoric sites from western Pennsylvania suggests that maize probably was grown in small quantities in the region during the early Late Woodland prior to ca. A.D. 900. It is unlikely that maize was introduced as a totally new and unknown crop around A.D. 900 and was immediately accepted and grown as a major staple by late Late Woodland/Late Prehistoric inhabitants of the region. If so, it would have required these populations to immediately change deeply ingrained settlement and subsistence practices without hesitation. It is far more likely that there was a period of small-scale experimentation with a new crop like maize prior to its full-fledged adoption and modification of local settlement and subsistence practices. There are claims for early maize from the region that might substantiate this view, including what would be the earliest macrobotanical evidence for maize from the East. It is imperative that the few samples of maize recovered from early contexts in Pennsylvania be AMS dated to confirm their ages. Direct AMS dates on samples of maize from the Midwest indicate it is possible that maize was present in Pennsylvania by the Late Woodland period and that some of these early

Pennsylvania samples may prove to be valid. Nevertheless, until such time that AMS dates are obtained, the claims for early maize from Pennsylvania must be questioned. In addition, large-scale flotation and analysis of samples from Late Woodland sites must be obtained to confirm the presence of maize and Eastern Agricultural Complex crops throughout the Late Woodland period. Samples of maize from Late Prehistoric contexts also should be AMS dated to ensure they are not later or modern contaminants.

The early Late Woodland (ca. A.D. 400 to 900) is a very important transition period between the Middle Woodland Hopewellian efflorescence and development of intensive maize horticulture societies during the late Late Woodland/Late Prehistoric period in Pennsylvania and the northern panhandle of West Virginia. Unfortunately, the early Late Woodland is also one of the least studied periods in the region. Much more work must be directed toward identifying and excavating sites from the early Late Woodland period. It is only through such work that the questions of when and how settled village life and maize horticulture developed will be answered.

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CHAPTER 3

THE IMPACT OF MAIZE-BASED AGRICULTURE ON PREHISTORIC PLANT COMMUNITIES IN THE NORTHEAST

by Nancy Asch Sidell

In the first volume of *Current Northeast Paleoethnobotany*, quantitative analysis of flotation and water-screened plant remains from 10 well-sampled Maine sites, a reconstruction of prehistoric plant communities, and an outline of plant use over a period of nearly 10,000 years was presented as a first step toward developing a regional synthesis (Asch Sidell 1999e). Subsequently, various archaeobotanical indicators were used to study anthropogenic influences on vegetation at 27 sites with 48 components dating 6350–190 B.P. from Maine to Pennsylvania (Asch Sidell 2002g).

Crawford and Smith (2003) presented a regional synthesis of paleoethnobotany in the Northeast in which they outlined the history of research and cultural chronology in the Great Lakes region, Atlantic Canada, and New England. The data were organized into three cultural patterns, Eastern Collecting (pre-maize), Northern Mixed Economy, and Northeastern Coastal. Most of the paleoethnobotanical data from Ontario and New York (Iroquoian) were presented as part of the Northern Mixed Economy pattern, and the New England mixed economy groups (Algonkian) were discussed as part of the Northeastern Coastal pattern. It was noted that the development of a mixed economy took several centuries, starting at about 1500 B.P. with the introduction of maize in southern Ontario. Tobacco was present in Ontario by 1100–1000 B.P. and bean by 730–665 B.P. There is a possibility that goosefoot, erect knotweed, and little barley were grown in precontact Ontario; there was also an occurrence of wild-sized marshelder far from its natural range (see Table 3-1 for Latin names). Resource diversity increased in Late Archaic deposits in Ontario, nut use declined through time, and use of fleshy fruits remained important at Late Woodland sites (Crawford and Smith 2003).

This chapter will add to the inventory of sites in Maine, Vermont, New York, and Pennsylvania that can contribute to a regional synthesis. The sites are grouped

according to the forest zone in which they are located, using the classification developed by Braun (1950). Altogether, this study includes 58 sites with 85 components, and 31 of the sites contained maize in 36 components, not including possibly intrusive maize (Figure 3-1, Table 3-2).¹ Dates associated with the various culture historic time periods and taxa are presented in Table 3-2. All dates in this chapter are uncalibrated. The sites in northern New England lie within the New England section of the hemlock–white pine–northern hardwoods forest region, which extends from Maine to northern Pennsylvania. In northern New England, maize sites are found in the warmer areas including the Champlain Valley in northwestern Vermont, the Connecticut River Valley between New Hampshire and Vermont, and in the Saco, Androscoggin, and Kennebec River valleys of southern and central Maine. Other forest regions included in this study are the beech–maple region on the southern edge of Lake Erie and Lake Ontario, the Piedmont section of the hemlock–white pine–northern hardwoods forest region, and the oak–chestnut region from Connecticut and the Hudson River Valley to southeastern Pennsylvania and central New Jersey (Figure 3-1). Each archaeobotanical analysis was undertaken to reconstruct the natural vegetation of the site area at the time of the occupation based on wood charcoal, nutshell, and seed analyses; to evaluate evidence for use of cultivated / domesticated plants; to assess the significance of wild plant foods; and to compare the results with other sites in the region. The archaeobotanical analysis by itself provides unique insights into plant use at a particular time and place. Compiling a portion of the data from each site into a summary paper such as this reveals trends and patterns in regional plant use that in turn make each subsequent site analysis more meaningful.

This chapter will first examine the evidence for ubiquity of maize at sites postdating 1190 B.P.; then wood charcoal

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Table 3-1. Latin and Common Names of Plants Referenced in the Text.

EASTERN AGRICULTURAL COMPLEX

Chenopodium berlandieri ssp. *jonesianum*, goosefoot
Helianthus annuus var. *macrocarpus*, common sunflower
Hordeum pusillum, little barley
Iva annua var. *macrocarpa*, marshelder, sumpweed
Phalaris caroliniana, maygrass
Polygonum erectum, erect knotweed

OTHER CULTIGENS

Cucurbita pepo ssp. *ovifera*, squash, pepo gourd
Nicotiana spp., tobacco
Phaseolus vulgaris, common bean
Zea mays ssp. *mays*, maize

WEED/ECONOMICALLY IMPORTANT SEEDS

Amaranthus spp., amaranth
Ambrosia trifida, giant ragweed
Amphicarpaea bracteata, hog peanut
Chenopodium spp., goosefoot
Desmodium spp., tick trefoil
Helianthus spp., ruderal/wild sunflower
§Persicaria, *Polygonum* spp., smartweed
Polygonum scandens, false buckwheat
§Polygonum, *Polygonum* spp., knotweed
Zizania spp., wild rice

FLESHY FRUIT SEEDS

Cornus canadensis, bunchberry
Crataegus spp., hawthorn
Fragaria spp., strawberry
Gaylussacia spp., huckleberry
Prunus spp., cherry
P. nigra, Canada plum
P. pensylvanica, pin cherry
Rubus spp., bramble (blackberry, raspberry, dewberry)
Sambucus spp., elderberry
Solanum americanum, black nightshade
Vaccinium spp., blueberry
Viburnum cassinoides, wild raisin
Vitis spp., grape

GRASS SEEDS (TECHNOLOGICAL?)

Andropogon gerardii, big bluestem
Echinochloa spp., barnyard grass
Elymus spp., wild rye

NUT TREES

Carya spp., hickory
C. cordiformis, bitternut hickory
C. ovata, shagbark hickory
Castanea dentata, chestnut
Corylus spp., hazelnut
Fagus grandifolia, beech
Juglans cinerea, butternut, white walnut
J. nigra, black walnut
Quercus spp., acorn

OTHER TREES for FIREWOOD

Acer spp., maple
A. saccharum, sugar maple
Betula spp., birch
B. alleghaniensis, yellow birch
B. nigra, black, river birch
Crataegus spp., hawthorn
Fraxinus spp., ash
Ostrya virginiana, hophornbeam
Pinus spp., pine
P. rigida, pitch pine
P. strobus, white pine
Populus spp., poplar
Prunus spp., cherry
Quercus spp., oak
Tilia americana, basswood
Tsuga canadensis, hemlock
Ulmus spp., elm
U. americana, white elm

MEDICINAL/BEVERAGE SEEDS

Aralia hispida, bristly sarsaparilla
A. racemosa, wild sarsaparilla
Comptonia peregrina, sweetfern
Galium spp., bedstraw
Liliaceae, lily family
Phytolacca americana, pokeweed
Rhus spp., sumac
Verbena spp., vervain

Note: Grouped according to inferred prehistoric use. Plants referenced in the text but not identified at an archaeological site are not included.

composition as it relates to forest regions; nutshell abundance in relation to percentage of oak, hickory, and chestnut trees near a site; and changes in seed types through time, including a detailed discussion of plants making up the Eastern Agricultural Complex. Finally, changes in vegetation that may have occurred with the introduction of maize agriculture are considered.

MAIZE UBIQUITY

It may have taken more than 1,000 years for maize to spread from southern Ontario and New York into northern New England. Based on phytoliths recovered from pottery sherd cooking residues, maize was grown in the northern Finger Lakes region of New York by 2270±35

B.P. (cal. 2σ 399–208 B.C.) and in the upper Susquehanna River valley by 1515±40 B.P. (cal. 2σ A.D. 434–613) (Hart et al. 2007; Thompson et al. 2004). The earliest direct date on maize in Vermont is 840±40 B.P. (cal. 2σ A.D. 1049–1271) from the Headquarters site, and there is a direct date on bean of 765±50 B.P. (cal. 2σ A.D. 1164–1378) from a maize and bean storage pit at the Skitchewaug site in Vermont (Petersen and Cowie 2002). In Maine at the Little Ossipee North site in the central Saco River valley, two maize cupule fragments were recovered from a feature dating to 1010±60 B.P. (cal. 2σ A.D. 894–1162). Direct dating of one cupule yielded a date of 570±40 B.P. (cal. 2σ A.D. 1299–1429). At the Early Fall site, located about 3 km downstream from Little Ossipee North, 70% of the feature samples contained remains of cultivated plants, including maize cob & kernel fragments, *Cucurbita pepo* rind, and

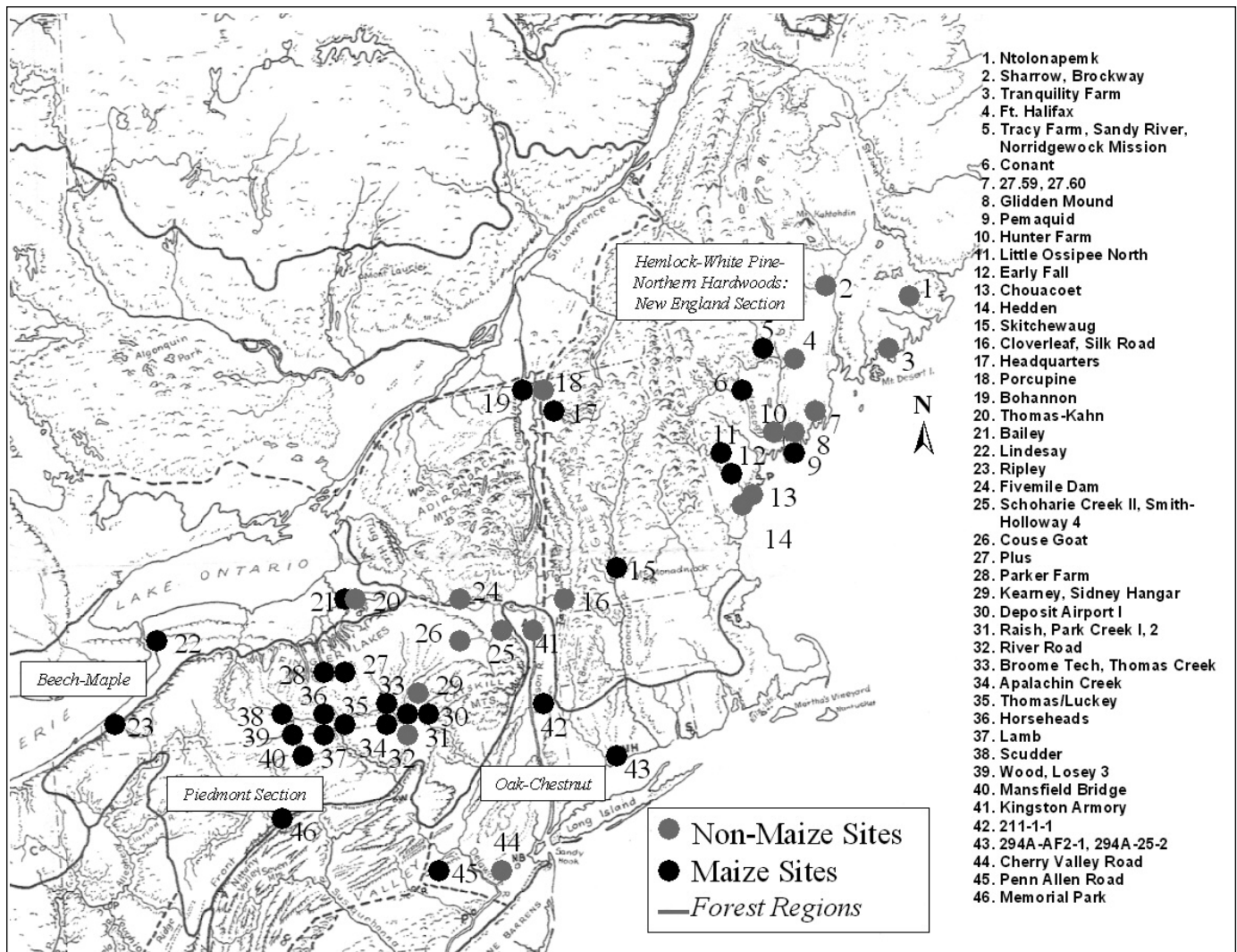


Figure 3-1. Site location map and forest regions of the Northeast (based on Braun 1950).

one bean. Radiocarbon dates on associated charcoal were 570 ± 40 B.P. (cal. 2σ A.D. 1299–1429) and 460 ± 60 B.P. (cal. 2σ A.D. 1319–1632) (Asch Sidell 1999e).

Most archaeological maize in the Northeast is recovered by flotation or water screening with 1mm or smaller mesh, and consists of tiny fragments of carbonized cupule, glume, embryo, or kernel. The density of maize at northeastern sites is quite variable, ranging from a low of 0.004 to 20.4 fragments of maize larger than 2 mm per gram of charcoal at the sites in this study (Table 5-2).² Leaving out the two extremes, the average amount of maize is 1.3 fragments larger than 2 mm per gram of charcoal. More significant than the quantity of maize recovered is the fact that maize was found at all but two of 33 sites with 38 occupations postdating 1190 B.P., regardless of the size or function of the sites. At the Thomas Creek site (1150–650 B.P.), a small campsite in the Chenango River floodplain in southcentral New York, the lack of

maize could relate to the small quantity of charcoal examined, only 13 grams. For example, a maize index of 0.004 fragments, such as was found at the Cayuga Iroquois Plus site (550–450 B.P.) in central New York, would require that about 250 g of charcoal be examined to find a maize fragment larger than 2 mm in size. The second site without maize postdating 1190 B.P. was Cherry Valley Road (790–670 B.P.), a small hunting camp located in a part of New Jersey with limited evidence for prehistoric occupation. The charcoal was preserved mostly in the heavy fraction, coated with thick clay skins which impeded identification, and only 109 g was examined. At the site with the lowest density of maize, the Cayuga Iroquois Plus site in New York, maize was found in 6 of 10 features yielding a total of 2,212 g of charcoal from 60 samples. There were eight fragments of maize larger than 2 mm as well as unquantified amounts from 0.5 mm to 2 mm in size. The remarkable ubiquity of small quantities of tiny

Table 3-2. Sites and Data Used in Constructing Figures and Tables.

FOREST REGION Site	Uncalibrated date BP: Component (no. dates)	Sample size (no./g)	Flotation/ WS/HP	% oak- hickory- chestnut	Nut- shell index*	Seed index*	Maize index*	No. seed types	% fleshy fruit	Reference
HEMLOCK-WHITE PINE- NORTHERN HARDWOODS: NEW ENGLAND SECTION										
Hedden	10,590-10,510: Paleoindian	16/6	F	-	-	2	-	4	73	Asch Sidell 1995a; Spiess & Mosher 1994; Spiess et al. 1995 Asch Sidell 2005b
Ntalonapemk (96.02), ME	8690-8270: Early Archaic (8) 6460-6470: Middle Archaic (2) 5840-3990: Late Archaic (9) 2490-520: Ceramic (8)	8/23 2/18 11/19 9/54	F F F F	25.71 22.22 18.13 15.46	.58 .23 .91 .15	3.68 1.52 9.57 5.61	- - - -	13 8 16 16	77 63 79 90	
Sharrow (90.2D), ME	6320-5695: M Archaic (5) 3650-3060: Late Archaic (2) 4730-4160: Late Archaic (2) 4370-4220: Moorehead (3)	44/152 3/36 31/74 53/81	WS WS F WS	28.5 1.25 31.39 -	.25 .17 .37 .58	.43 - .19 1.21	- - - -	7 - 5 16	56 - 79 70	Petersen 1991; Petersen & Asch Sidell 1996 Asch Sidell 1989a Asch Sidell 1989b; Bartone & Petersen 1992 Asch Sidell 1993
Hunter Farm (15.110), ME	3740-3670: Susquehanna (3) 4140-4020: Mhd-Susque. (4) 3150-2410: Early Ceramic (4)	17/75 44/160 6/64	WS F F	- 46.74 45.91	- .03 .06	.04 .05 .25	- - -	3 3 3	13 8 8	
Brockway (90.3), ME	3280-3100: Late Archaic (4) 2360: Ceramic (1) 2410-2270: EW (3) 1890: EMW (1)	97/392 75/322 10/330 4/103	WS+F F WS** F+WS	1.15 21.56 31.42 1.18	1.43 .03 0 5.21	0.1 .03 0 0.01	- - - -	8 - 0 1	12 100 - -	Asch Sidell 2001d Asch Sidell 1990c Asch Sidell 1990b
27.59, ME	2000: E. Middle Ceramic (1) 2200-1500	4/19 4/58 2/8	F F+HP F	0 12.11 3.33	.48 4.26 -	.11 .23 2.73	- - -	2 4 3	50 67 18	Asch Sidell 2002b Asch Sidell 1993 Asch Sidell 2000k Asch Sidell 2000d
Glidden Mound (26.1), ME	2150-1840: Middle Woodland 450: LW/Contact 335-255: Contact	5/168 18/404 7/8	WS+F WS+F WS	6.47 11.89 0	.62 .6 .12	2.23 1.79 .24	.89 1.99 -	21 23 2	47 28 -	
Silk Road (BE-33), VT	1390: Middle Ceramic (1) 1930: Middle Ceramic (1)	4/14 5/102	WS F	9.41 7.5	1.51 .04	1.43 .91	- -	6 11	2 33	Asch Sidell 2001e Asch Sidell 2000a Asch Sidell 1999b
Chouacoet (5.06), ME	1280: E. Middle Ceramic (1) 1010-570: Late Ceramic (3) 850-600	6/336 20/234	F WS	14.67 59.85	.95 18.33	3.01 1.44	.01 2.07	16 23	95 10	Asch Sidell 1996a; Will et al 1996 Asch Sidell 2002a; Heckenberger et al. 1992
Tranquility Farm (44.12), ME	840-410 (4) 570-460 (3) 520-490 (1)	9/150 20/101 4/14	F+WS WS F	22.73 2.99 25.71	40.82 2.91 .44	0.45 1.15 1.24	0.19 .70 .37	10 19 5	69 38 41	Asch Sidell 2002b Asch Sidell 1990a Asch Sidell 2000g; Spiess & Cranmer 2001
Little Ossipee N (7.7), ME	550-450: Iroquois 530-300: Contact 390-220	14/428 7/88 9/79	F+WS WS F+WS	- .89 54.21	.002 1.2 1.21	.04 0.28 2.92	.98 8.3 1.8	5 13 15	- 32 31	Asch Sidell 2002a Asch Sidell 1992a Asch Sidell 2002f
Skitchewaung (WN-41), VT	255-190: Contact	61/295+	WS+F	13.01	0.98	.89	1.67+	27	29	Asch Sidell 1992a, 1996b, 2002c
BEECH-MAPLE										
Headquarters (FR-318), VT	840-410 (4) 570-460 (3) 520-490 (1)	9/150 20/101 4/14	F+WS WS F	22.73 2.99 25.71	40.82 2.91 .44	0.45 1.15 1.24	0.19 .70 .37	10 19 5	69 38 41	Asch Sidell 2002b Asch Sidell 1990a Asch Sidell 2000g; Spiess & Cranmer 2001
Early Fall (7.13), ME	550-450: Iroquois 530-300: Contact 390-220	14/428 7/88 9/79	F+WS WS F+WS	- .89 54.21	.002 1.2 1.21	.04 0.28 2.92	.98 8.3 1.8	5 13 15	- 32 31	Asch Sidell 2002a Asch Sidell 1992a Asch Sidell 2002f
Pemaquid (16.2), ME	255-190: Contact	61/295+	WS+F	13.01	0.98	.89	1.67+	27	29	Asch Sidell 1992a, 1996b, 2002c
Bohannon (GI-26), VT	4000-3000: Transitional 950-500 650-300	3/38 21/377 135/839	F F F	- 44.75 12.16	0.3 .26 1.06	1.03 .03 1.73	- .63 3.59	4 4 18	97 18 94	Asch Sidell 2004c Asch Sidell 2002h Asch Sidell 2006d; Neusius et al. 1998
Sandy River (29.24), ME	550-290	15/1174	F	12.96	.04	.61	20.37	17	29	Asch Sidell 2004c
Conant (35.15), ME										
Norridgewock Mission (69.2), ME										
PIEDMONT SECTION										
Thomas-Kahn, NY	4000-3000: Transitional 950-500 650-300	3/38 21/377 135/839	F F F	- 44.75 12.16	0.3 .26 1.06	1.03 .03 1.73	- .63 3.59	4 4 18	97 18 94	Asch Sidell 2004c Asch Sidell 2002h Asch Sidell 2006d; Neusius et al. 1998
Lindesay, NY	550-290	15/1174	F	12.96	.04	.61	20.37	17	29	Asch Sidell 2004c
Ripley, NY										
Bailey, NY										
PIEDMONT SECTION										
Fivemile Dam (130-10-1), NY	6260-5230: Otter-Brewer (4) 4300-3180: LA-TA (10) 4950-3950: Brewerton	7/38 71/218 4/29	F F F	- 1.81 41.82	43.4 4.34 -	.21 .25 .07	- (.005) -	2 10 2	- 72 50	Asch Sidell 1992d; Cassidy 1998 Asch Sidell 2000c Asch Sidell 1999d
Raish, NY	4450-3750: Lamoka-Norman.	34/195	F	5.65	.5	.02	-	3	75	

Table 3-2. Sites and Data Used in Constructing Figures and Tables. *Continues*

FOREST REGION Site	Uncalibrated date BP: Component (no. dates)	Sample size (no./g)	Flotation/ WS/HP	% oak- hickory- chestnut	Nut- shell index*	Seed index*	Maize index*	No. seed types	% fleshy fruit	Reference
Park Creek I, NY	3650–3450: Snook Kill	14/24	F	9.48	.57	.65	-	5	69	Asch Sidell 2000e
Schoharie Creek II, NY	3450–2050: Transitional-EW	10/76	F	24.50	.01	.03	-	2	100	Asch Sidell 2001b
Smith-Holloway 4, NY	3450–1950: Transitional-EW	9/41	F	15.00	.83	-	-	-	-	Asch Sidell 2004b
Park Creek II, NY	1050–400: Late Woodland	22/782	F	16.19	.01	.01	.06	4	43	Asch Sidell 2000f; Miroff 2002
Plus, NY	550–450: Cayuga Iroquois	60/2212	F	.37	.001	.03	.004	12	69	Asch Sidell 1999a
Parker Farm, NY	425–400: Cayuga Iroquois	9/58	F	21.19	.09	.07	.77	2	75	Asch Sidell 2001c
PIEDMONT BOTTOMS***										
Mansfield Bridge, PA	8780–4440: MA-TA	17/33	F	22.56	7.6	.12	-	1	-	Asch Sidell 2002d
Sidney Hangar, NY	1150–940: Early Owasco	20/396	F	28.42	3.66	1.06	.65	11	25	
River Road, NY	4950–3950: Late Archaic	7/222	F	31.45	.13	.36	-	2	94	Asch Sidell 2005c
	3650–3450: Snook Kill	4/107	F	3.75	.07	.03	-	-	-	Asch Sidell 2004a
Broome Tech, NY	2900–2150: Transitional	68/357	F	58.89	4.27	.24	(3)	15	10	Asch Sidell 1999c
	1960–1050: Middle Woodland	14/369	F	22.18	.17	.03	-	4	33	
	950–700: Owasco	110/492	F	64.69	2.95	.58	.99	20	52	
Kearney, NY	2050–1890 (1)	8/126	F	7.74	.26	.07	-	3	89	Asch Sidell 2000b
Deposit Airport I, NY	1250–750	42/173	F	49.78	5.39	2.26	.25	17	41	Asch Sidell 2002e
Apalachin Creek, NY	1050–850	42/100	F	50.27	.16	.37	.06	5	77	Asch Sidell 2000i
Lamb, NY	1150–650	28/746	F	6.37	.2	.17	.01	7	95	Asch Sidell 2000h
Thomas Creek, NY	1150–650: Early LW	14/13	F	61.58	1.57	.52	-	6	29	Asch Sidell 2000j
Horseheads, NY	1050–450	6/83	F	75.47	7.84	.16	.20	4	89	Asch Sidell 2003
Wood (36T124), PA	950–850: Late Woodland	26/84	F	21.62	.2	.08	.17	3	14	Asch Sidell 2006b
Scudder, NY	950–650	5/81	F	7.00	.22	.93	1.07	13	71	Asch Sidell 2002i
Thomas/Luckey, NY	650–500: Early Late Woodland	38/259	F	35.98	1.2	2.4	2.0	18	10	Asch Sidell 2001a; Knapp 2002
Losey 3 (36T128), PA	790–260: Owasco, Shenks Ferry, Susquehannock (10)	125/267	F**	24.14	1.74	1.26	3.38	4	95	Asch Sidell 2006a
OAK-CHESTNUT										
Memorial Park, PA	6355–5790: E Laurentian	27/19	F	50.00	1.26	.05	-	1	-	Asch Sidell 1995b
	5200–4900: L Laurentian	17/40	F	39.71	18.6	.07	-	1	-	Hart & Asch Sidell 1996
	4410–4050: Piedmont	6/77	F	30.59	.22	.04	-	3	33	
	4050–3590: Canfield	55/238	F	47.93	2.05	.03	-	5	14	
	3095–2830: Orient-Meadowd.	12/30	F	43.62	6	.03	-	-	-	
	1190–1120 : E Clemson ls. (5)	16/99	F	86.667	5.61	2.12	1.19	16	12	
	1030–985: M Clemson ls. (4)	6/10	F	52.00	2.27	8.44	2.27	5	1	
	900–860: L. Clemson ls. (5)	4/28	F	75.00	5.73	2.60	.52	5	3	
	660–565: Stewart Phase (4)	12/52	F	65.00	1.61	1.55	.82	10	36	
Kingston Armory, NY	4550–4520 (2)	6/342	F	75.00	19.63	-	-	-	-	Asch Sidell 2006e
294A-AF2-1, CT	3800–3230: TA-EW (5)	8/53	F	79.41	6.91	-	-	-	-	Asch Sidell 1992c; Millis et al. 1995
	2060: Woodland (1)	12/12	F	63.64	5.66	-	-	-	-	
294A-25-2, CT	440–430: LW-Final W (2)	7/115	F	84.51	3.11	.14	.52	3	-	Asch Sidell 1992c; Millis et al. 1995
	1930–1760: EW-MW (3)	9/40	F	86.96	5.79	.30	.14	3	83	
211-1-1, NY	790–220: LW (8)	11/66	F	93.49	2.45	.64	.04	9	5	
	1100–850: Late MW (4)	11/190	F	49.18	1.05	1.34	.04	10	13	Asch Sidell 1992b; Webb &
Cherry Valley Road, NJ	390–240: LLW-Contact (3)	15/195	FF	45.62	.67	2.19	.06	15	24	Dowd 1995
Penn Allen Road, PA	790–670: Late Woodland (1)	6/109	F	92.51	33.6	0.01	-	1	100	Asch Sidell 2006c
	1080–330: Late Woodland (3)	4/29	F	100.00	0.66	0.66	0.55	4	42	Asch Sidell 2005a

Notes: WS= water-screened. HP = Hand picked. *Nutshell index = number of nutshell fragments larger than 2 mm per g of total charcoal. Seed index = number of seeds larger than 0.5 mm per g of total charcoal. Maize index is number of maize fragments larger than 2 mm per g of total charcoal. () = probably intrusive. **Nutshell and seed indices may not be accurate for Evergreens site, because of charcoal collection methods, and for Losey 3 bucket flotation method, which did not recover any seeds smaller than 2 mm. ***Bottomlands in Hemlock-White Pine-Northern Hardwoods Forest Region: Piedmont Section are within migration area for southern species, as mapped by Braun (1950). Unusual abbreviations are Mhd-Susque. = Moorehead-Susquehanna; Otter-Brewer. = Otter Creek-Brewerton; Lamoka-Norman. = Lamoka-Normanskill.

Table 3-3. Maize, Cucurbit, Bean, Tobacco, Eastern Agricultural Complex, and Wild Rice

FOREST REGION Site	Date B.P.	Cucurbit	Maize >2 mm	Sun- flower	Marsh- elder	Goose- foot	Little barley	Erect knotweed	Bean	Tobac- co	Wild Rice
HEMLOCK-WHITE PINE-NORTHERN HARDWOODS: NEW ENGLAND SECTION											
Ntolonapemk, ME	6460-6470	-	-	-	-	[4]	-	-	-	-	-
Sharrow, ME	6320-5695	[1]	-	-	-	-	-	-	-	-	-
Ntolonapemk, ME	5840-3990	-	-	-	-	[10]	-	-	-	-	-
Hunter Farm, ME	4730-4160	-	-	-	-	[1]	-	-	-	-	-
Glidden Mound, ME	2200-1500	-	-	-	-	[17]	-	-	-	-	-
Ntolonapemk, ME	2490-520	-	-	-	-	[2]	-	-	-	-	-
Tranquility Farm, ME	1280	-	-	-	-	[8]	-	-	-	-	-
Little Ossipee North, ME	1010-570	-	2	-	-	-	-	-	-	-	-
Skitchewaug, VT	850-600	1	485	-	-	-	-	-	48	-	-
Headquarters, VT	840-410	-	28	-	-	[408]	-	-	-	-	81
Pemaquid, ME	520-490	-	3	-	-	-	-	-	1	-	-
Bohannon, VT	550-450	-	418	-	-	-	-	-	-	-	-
Early Fall, ME	570-460	3	72	[1?]	-	[1]	-	-	1	-	-
Tracy Farm, ME: LW	450	3	150	-	-	[2]	-	-	2	-	-
Sandy River, ME	530-300	1	732	-	-	-	-	-	-	-	-
Conant, ME	390-220	-	157	-	-	[1]	-	-	-	-	-
Tracy Farm, ME: Contact	335-255	3	803	[1]	-	[30]	-	-	-	-	-
Norridgewock Mission, ME	255-190	4	491+	-	-	[116]	-	-	6	-	-
BEECH-MAPLE											
Lindesay, NY	950-500	-	239	-	-	[7]	-	-	-	-	-
Ripley, NY	650-300	-	3,012	2 [1]	-	[11]	-	-	17	1	-
Bailey, NY	550-290	2	23,917	1	-	[14]	-	-	109	1	-
HEMLOCK-WHITE PINE-NORTHERN HARDWOODS: PIEDMONT SECTION											
Scudder, NY	950-650	-	87	[1]	-	2,[3]	-	[1]	-	-	-
Park Creek II, NY	1050-400	-	50	[1]	-	-	-	-	-	-	-
Plus, NY	550-450	-	8	1	-	-	-	-	-	-	-
Parker Farm, NY	425-400	-	45	-	-	-	-	-	-	-	-
HEMLOCK-WHITE PINE-NORTHERN HARDWOODS: PIEDMONT SECTION BOTTOMS											
Broome Tech, NY	2900-2150	-	(3)	-	[2]	[18]	-	-	-	-	-
Mansfield Bridge, PA:	1150-940	2	257	1	3	>9[281]	-	-	-	-	-
Deposit Airport I, NY	1250-750	3	44	-	-	>1[32]	-	-	-	-	-
Apalachin Creek, NY	1050-850	-	6	-	-	-	-	-	-	-	-
Lamb, NY	1150-650	-	7	[1]	-	-	-	-	-	-	-
Wood, NY	950-850	2	14	-	-	-	-	-	-	-	-
Broome Tech, NY	950-700	30	473	-	-	-	-	-	4	-	-
Horseheads, NY	1050-450	-	21	-	-	[1]	-	-	-	-	-
Thomas/Luckey, NY	700-600	-	524	3	-	[27]	-	-	190	-	-
Losey 3, NY	790-260	-	903	-	-	-	-	-	12	-	-
OAK-CHESTNUT											
Memorial Park, P A	5200-4900	[2]	-	-	-	-	-	-	-	-	-
Memorial Park, PA	3095-2830	10	-	-	-	-	-	-	-	-	-
Memorial Park, PA	1190-1120	-	117	[1]	-	19	119	-	-	-	-
Memorial Park, PA	1030-985	-	11	-	-	-	101	-	-	-	-
211-1-1, NY	1100-850	-	8	-	-	-	-	-	-	-	-
Memorial Park	900-860	-	15	-	-	2	70	-	-	-	-
Memorial Park	660-565	-	43	-	-	-	20	-	-	1 LW	1 LW
Penn Allen Road	1080-330	1	16	-	-	-	-	-	-	-	-
294A-25-2, CT	790-220	-	9	-	-	[1]	-	-	-	-	-
294A-AF2-1, CT	440-430	-	58	-	-	-	-	-	-	-	-
211-1-1, NY	390-240	-	11	-	-	-	-	-	-	-	-

Note: [] = not domesticated; () = intrusive?; LW = Late Woodland; + = 2,972 fragments from a smudge pit with only 1/4" charcoal submitted for analysis was not included.

maize fragments at all types of sites throughout the Northeast is perhaps the best indication of the widespread importance of maize agriculture after 1190 B.P.

At only one of the 36 occupations with maize was there evidence that the maize may have been imported from another location. At the Lindesay site (950-500 B.P.), located along a pioneer (and prehistoric?) trail on a high bluff

overlooking the lower Niagara River in the beech-maple forest region of New York, 92% of the maize fragments were kernel and embryo. The paucity of cob fragments (cupules, glumes) may mean that maize was not grown and processed near the site. If the maize were present as travel food for a temporary camp, it would more likely be in the form of parched kernels, whole dried kernels, or

corn meal, which are less bulky to transport. The relatively high frequency of kernel fragments at Lindesay site together with a low frequency of nutshell and seeds may indicate that the maize was a travel food imported from another location rather than a crop that was grown near the site.

Also located in the beech–maple region south of Lake Ontario in New York, the Bailey site (550–290 B.P.) had an even higher percentage (96.5%) of kernel and embryo fragments, but cob fragments were ubiquitous in 12 out of 15 samples. At Bailey site there were about 24,000 fragments of maize larger than 2 mm in association with 109 bean fragments, two tiny squash/pepo gourd rind fragments, one sunflower kernel, one tobacco seed, 14 ruderal/wild goosefoot (*Chenopodium berlandieri*), as well as six kinds of fleshy fruit (hawthorn, strawberry, bramble, elderberry, blueberry, and grape), and five types of medicinal plant seeds (bedstraw, sumac, pokeweed, smartweed,³ and vervain). The presence of several cultigens and the relative abundance and diversity of seeds suggest that maize was grown near the site and that the anthropogenic environment provided by field edges and abandoned fields was the probable source of the diversity of seeds.

At more than half of the 36 occupations with maize, the maize was found in association with other cultivated plants including cucurbit (squash, pumpkin, pepo gourd), bean, tobacco, and members of the Eastern Agricultural Complex—sunflower, goosefoot, marshelder, and little barley. However, only five occupations had all three elements of the maize–bean–squash triad (Table 3-3). Bean did not enter the northern Eastern Woodlands until the late calibrated thirteenth century A.D. (Hart et al. 2002). The cucurbit and bean remains will not be described in detail in this report, but two new finds of tobacco merit special consideration (see below).

FOREST REGIONS AND WOOD CHARCOAL

The most abundant and easily studied charcoal category at any archaeological site is wood charcoal, which is generally presumed to be firewood from everyday cooking fires. Assuming wood is collected near the site, a firewood analysis can be used to detect changes in vegetation through time at a particular location. For this study, the wood charcoal was grouped by indicator species into categories of “mesic forest” (beech, maple, birch, basswood, hophornbeam, hemlock, white pine), “dry, open woods” (oak, hickory, chestnut), “floodplain/bottomland forest” (ash, elm, etc.), “disturbed woods/thickets” (cherry, hawthorn, poplar, pitch pine) (Asch Sidell 2002g). Sites were assigned to forest regions as defined and mapped by Braun (1950). Looking at wood charcoal composition, it is evident that there are regional differences in archaeolog-

ical wood charcoal that relate to the vegetational differences described by Braun (Figure 3-2). The sites ranged from Paleoindian through Contact period (ca. 10,550–190 B.P.), left to right, within each forest region. Most sites had a great variety of wood types even if there was a poor selection of nutshell and seeds. For example, in New York at Smith-Holloway 4 site (3450–1950 B.P.), where no seeds were preserved, there were 12 categories of wood charcoal from 200 identified fragments. At the nearby contemporaneous Schoharie Creek II site (3450–2050 B.P.), there were 16 categories of wood identified from 151 fragments.

Sites in northern New England, New York, and northern Pennsylvania had a high frequency of species characteristic of the mature hemlock–white pine–northern hardwoods forest region. In New York, the chestnuts, oaks, and hickories of the southern forests extended up the major river valleys, and there tended to be a higher frequency of oak and hickory in those locations, indicated as Piedmont Bottoms in Figure 3-2. Sites in and adjacent to the oak–chestnut forest region in southern New England, southeastern New York, and central Pennsylvania had a much higher percentage of oak, hickory, and chestnut wood charcoal. The oak–hickory–chestnut forest is generally a more open woodland, with fire-tolerant vegetation. The vegetation of the Lake Erie and Lake Ontario lowlands in Late Woodland/Protohistoric times was a mosaic of plant communities dominated by a beech–maple forest. According to Braun (1950), the average dominance of beech and sugar maple in climax communities in the beech–maple region is usually about 80%, but this part of New York State was affected by an influx of southern species during the xerothermic period.

NUT TREES AND NUTSHELL

Another important component of the carbonized remains at many archaeological sites is nutshell, which is generally a mixture of types. Crawford and Smith (2003) found that although resource diversity increased in Late Archaic deposits in Ontario, nut use declined through time. Outside of Ontario, in the area covered by the present study, there was not a noticeable decline in nut use through time. To determine if variations in overall nutshell frequency between sites and between occupations at the same site could be related to the types of trees that grew near the site rather than to cultural differences in the way nuts were collected or processed, in this study all types of nutshell were grouped together to create a nutshell index composed of acorn, beechnut, butternut, black walnut, chestnut, hazelnut, hickory nut, and bitternut hickory shells. The index was calculated as the total number of shell fragments larger than 2 mm divided by the

Wood Charcoal

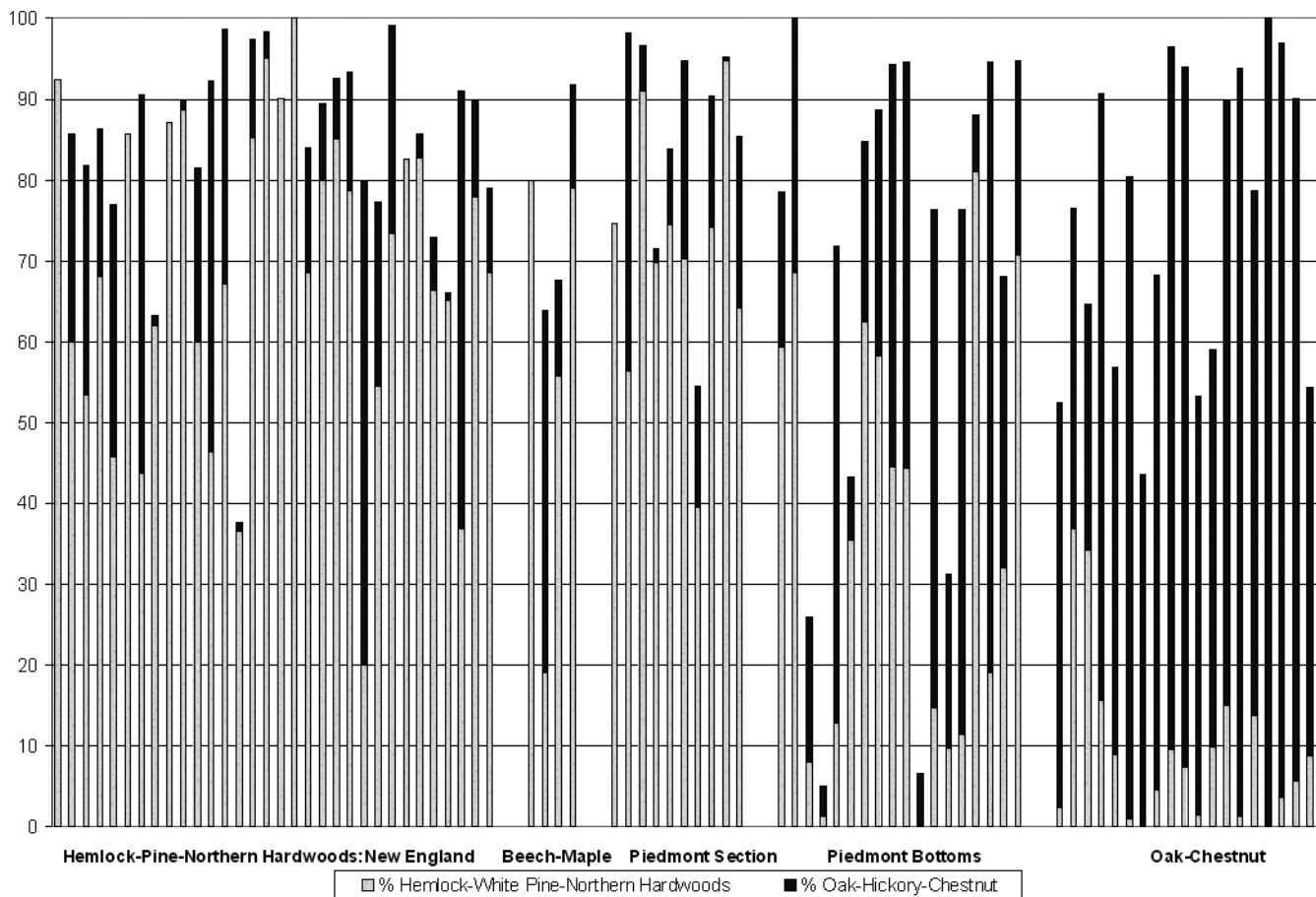


Figure 3-2. Wood charcoal from archaeological sites arranged by site/component, from oldest to youngest (left to right) within each forest region. Time interval is about 10,590–190 B.P. for the New England section of the hemlock–white pine–northern hardwoods forest region, 4000–300 B.P. for the beech–maple region, 6260–400 B.P. for the Piedmont section of the hemlock–white pine–northern hardwoods forest region, 8780–260 B.P. for the Piedmont bottomland sites in southern New York and northcentral Pennsylvania, and 6355–220 B.P. for the oak–chestnut forest region.

total weight of charcoal larger than 0.5 mm. Plotting the percentage of oak, hickory, and chestnut wood charcoal (indicative of relatively open, dry forest) versus the nut-shell index, there was generally a direct relationship between the amount of oak and hickory wood charcoal and the frequency of nutshell in each area (e.g., Figure 3-3) except in Maine, where there are fewer species of oak and hickory (Asch Sidell 2002g).

In Maine most sites had a mean of 16% oak wood and only 0.7 nutshell fragments per gram of charcoal ($n=26$ components). In the oak–chestnut region, sites had a mean of 66% oak, chestnut, and hickory wood charcoal together with a high index of 6.5 nutshell fragments per gram of charcoal ($n=19$ components). For Vermont, Figure 3-3 shows dramatic differences in nutshell indices between sites with more than 22 % oak and hickory wood

versus sites/components with 1% or less oak and hickory wood charcoal. In New York, in the Piedmont section of the hemlock–white pine–northern hardwoods forest region, the sites averaged 17% oak–hickory–chestnut wood charcoal and only 0.25% nutshell fragments per gram of charcoal ($n=8$ components), even less than in Maine where there are far fewer types of nut trees. The Piedmont calculations excluded bottomland sites in southcentral New York and the Fivemile Dam site (6260–3180 B.P.) in the middle Mohawk River valley. In the Piedmont bottoms of southcentral New York and northcentral Pennsylvania where Braun predicted more southern species, the sites had an average of 33% oak–hickory–chestnut wood charcoal and 6.2 nutshell fragments per gram of charcoal ($n=18$ components). Leaving out the highest (Horseheads, 1050–450 B.P.) and

Vermont Sites

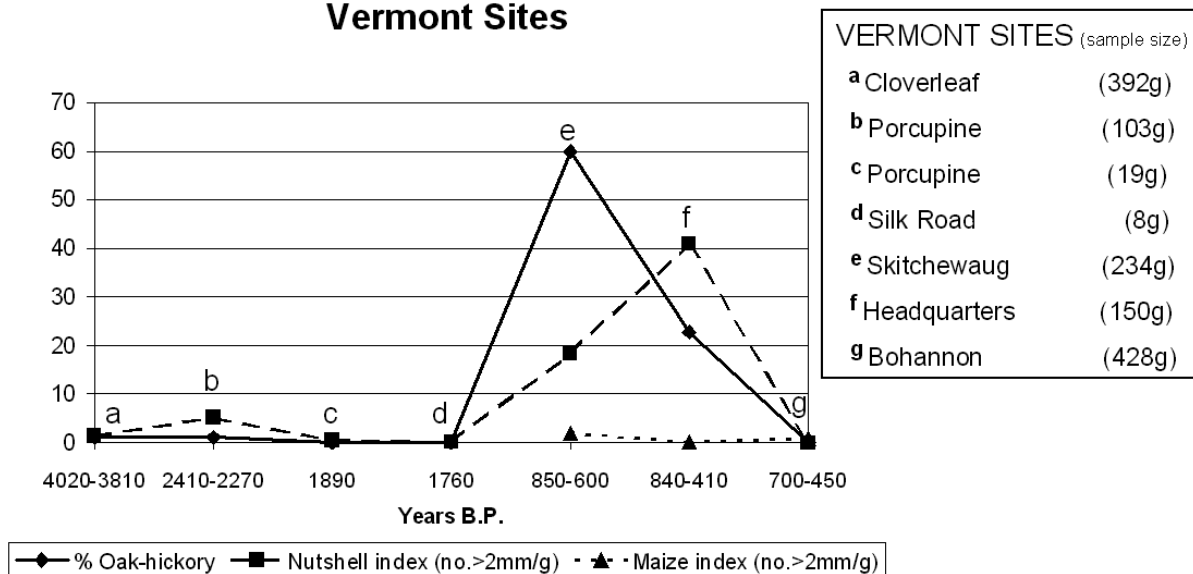


Figure 3-3. Nutshell density (dashed line) in relation to percentage of oak, hickory, and chestnut wood charcoal (black line) and maize index (dotted line). The nutshell index and maize index are the number of fragments larger than 2 mm per gram of total charcoal.

lowest (River Road site, 4950–3930 B.P.) nutshell index, the remaining sites in the Piedmont bottomlands had 33% oak-hickory-chestnut wood charcoal and 1.7 nutshell fragments per gram of charcoal ($n=16$ components), intermediate between the upland Piedmont sites and the oak–chestnut forest region sites. The generally greater nutshell density at sites located near abundant oak, hickory and/or chestnut trees, together with the wide diversity of nutshell types identified at most sites, is interpreted to mean that nut resources were used for food whenever they were available near a site, whether or not maize was grown.

Role of butternut

Butternut extends throughout much of the Northeast but is a locally abundant species that tends to grow in rich or rocky woods, often along streams (House 1924). At three Late Archaic sites in eastcentral New York and southwestern Vermont, butternut shell was present in large amounts. Kingston Armory site, with AMS dates of 4550 ± 40 B.P. (cal. 2σ 3370–3100 B.C.) and 4520 ± 40 B.P. (cal. 2σ 3350–3020 B.C.) (Hope Luhman, personal communication), had 86% nutshell in 342 g of charcoal, mostly butternut shell and husk. The Kingston Armory site was located in the oak–chestnut forest zone that extends up the Hudson River Valley in an area where uplands are normally forested with hemlock, white pine, and northern hardwoods. There was a paucity of wood charcoal, but based on an analysis of only 32 fragments from 5 samples, it appeared that 75 percent of the firewood at the Kingston Armory site was collected from oak and hickory

trees. The abundance of butternut shell indicated that a butternut grove must also have grown nearby.

Two other sites with larger than expected amounts of nutshell were Late Archaic River phase—the Cloverleaf site (4520–3810 B.P.) at the confluence of Waloomsic River and Furnace Brook in Bennington, Vermont, and the Fivemile Dam site (4300–3180 B.P.) in the middle Mohawk River Valley in Herkimer County, New York. The Fivemile Dam site had three large contemporaneous (ca. 3960–620 B.P.) platform hearths (Cassedy 1998). According to Braun (1950), the predominant upland vegetation in southwestern Vermont and in the middle Mohawk Valley before settlement was hemlock, white pine, and northern hardwoods such as sugar maple, beech, basswood, yellow birch, and white elm. The Cloverleaf and Fivemile Dam sites were quite similar in composition of plant communities, with beech dominating in the wood charcoal assemblage at each site, 60% beech at Fivemile Dam and 33% at Cloverleaf. There was only 1–2% oak and hickory wood charcoal. The overall impression at both sites is that nutshell density was somewhat greater than for other Archaic sites in the hemlock–white pine–northern hardwoods forest region. Butternut was by far the most abundant type of nutshell recovered at both sites (95% of the nutshell at Fivemile Dam and 85% at Cloverleaf site), suggesting that the sites were favorably located near a butternut grove. Still, the diversity of nutshell types recovered indicated that inhabitants of both sites probably made use of all the other types of nuts that grew in the area when they were available. For example, at Cloverleaf where 85% of the shell

was butternut, there was also 9% hazelnut, 4% bitternut hickory, 1% acorn, 1% hickory, and 0.5% beechnut (Asch Sidell 2001d). The natural range of black walnut and chestnut did not extend into southwestern Vermont (Little 1971, 1977).

SEED DENSITY AND VARIETY

In the first summary of plant use in Maine, it seemed that a greater quantity and variety of seeds had been recovered from sites postdating 1000 B.P., perhaps coincident with the introduction of maize agriculture (Asch Sidell 1999e). With the addition of new data from Ntolonapemk site (8690–520 B.P.) in eastern Maine, it now seems that the disparity between Archaic and Late Woodland/Contact sites was due in part to use of water screening rather than flotation sampling at many of the earlier sites in Maine. In the New England section of the hemlock–white pine–northern hardwoods forest zone, several components dating earlier than ca. 4000 B.P. in Maine and Vermont had a greater variety of seed types and a higher seed index than those dating ca. 4000 B.P. to ca. 1500 B.P. (Table 3-1).

In the other forest regions (i.e., Piedmont section of the hemlock–white pine–northern hardwoods, beech–maple, and oak–chestnut), most of the pre-maize sites had a very low seed index and few types of seeds. After ca. 1500 B.P. most of the sites had maize, a higher seed index, and a greater variety of seed types including weeds, legumes, and grass. Sites with the highest maize indices tended to have a much larger variety of seed types. The wild legumes most often associated with maize in the Northeast are perennials, including hog peanut and tick trefoil. Seeds from the perennial grasses big bluestem and wild rye have been found associated with grass stems in storage pits. Wild rice was found at one northern Vermont site and at Memorial Park site in central Pennsylvania in association with maize. Hart et al. (2003) have shown that maize was consumed with squash and wild rice in the northern Finger Lakes region of New York as early as ca. 1400 B.P.

Fleshy fruits

Seeds from fleshy fruits are a high proportion of the seed remains at most Archaic sites and at many Woodland sites. At the Paleoindian Hedden site in Maine, located on a glacial outwash surface deeply buried beneath sand dunes, there was a relatively high density of two seeds per g of charcoal, recovered by flotation sampling. At Hedden, although only 5.5 g of flotation charcoal from 16 samples was available for analysis, there were 11 seeds recovered. Surprisingly, all of the seeds were from fleshy fruits: bunchberry, bristly sarsaparilla, bramble, and

grape,⁴ although bristly sarsaparilla is more properly classified as a medicinal plant.

Even at Late Woodland/Contact sites where fleshy fruits may be a smaller proportion of the seed remains, fleshy fruits remain important. For example, in Maine at three sites in the Norridgewock Village area, fleshy fruit seeds were 28–36% of the seed remains, but there were at least 12 kinds of fleshy fruits that were utilized, including hawthorn, bunchberry, strawberry, huckleberry, Canada plum, pin cherry, chokecherry, blackberry/raspberry, elderberry, blueberry, wild raisin, and grape. Also present were fleshy fruits classified as medicinal, consisting of bristly sarsaparilla and wild sarsaparilla. The great variety represented indicated that fruits were an important part of the diet in the Late Woodland/Contact period. Various combinations of these and other fruits are found at northeastern sites throughout prehistory. The only fruit unique to sites with maize agriculture is *Solanum americanum*, black nightshade, found at Late Woodland and Mississippian sites in the Midwest (N. Asch and D. Asch 1985a:155) as well as in the Northeast at Memorial Park site (1190–565 B.P.) in Pennsylvania, and Broome Tech (950–700 B.P.) and Scudder (950–650 B.P.) sites in New York.

Archaic seeds

The Ntolonapemk site in eastern Maine was a surface site occupied over a period of 8000 years at the outlet of Meddybemps Lake. According to Passamaquoddy tradition, Ntolonapemk was a stopping point on a canoe route connecting coastal and interior regions by way of Dennys River and St. Croix River. Plant remains from the least disturbed contexts were classified as Early Archaic (8690–8270 B.P.), Middle Archaic (6460–6470 B.P.), Late Archaic (5840–3990 B.P.), Terminal Archaic (3240–2920 B.P.), Early Ceramic (2490–2250 B.P.), Middle Ceramic (1380–1360 B.P.), and Late Ceramic (980–520 B.P.). Hazelnut in small amounts was found in each of these occupations, acorn in most, and beechnut shell from Early and Late Ceramic, although beech wood was present in all occupations. The overall seed index (no. seeds >0.5 mm/g charcoal) was very high for this site, in part the result of using flotation sampling rather than water screening to recover seeds such as blueberry that are smaller than 1 mm. Seeds of fleshy fruits were by far the most abundant category, comprising 63–95% of all seeds from the Early Archaic through the late Ceramic (Table 3-2). The seeds included, in order of abundance, bramble, blueberry, elderberry, bunchberry, huckleberry, and pin cherry. Bristly sarsaparilla was also identified and classified as a medicinal plant in the Early Archaic and Ceramic components. Other seeds from medicinal plants found throughout the Archaic and Ceramic periods at Ntolonapemk were sumac, smartweed, and bedstraw, as

well as sweetfern from the Middle Ceramic. Of particular interest was the category of weed seeds that could be of economic importance, including goosefoot (*C. berlandieri*) and tick trefoil. Previously, these seeds had been identified primarily at Maine sites in association with maize agriculture, but Ntolonapemk is east of the area considered favorable for maize agriculture (Asch Sidell 1999e). However, the site is in the Maine Coastal Climate zone, which tends to have a growing season 18 to 23 days longer than elsewhere in the state (Baron and Smith 1996). The goosefoot was positively identified from Middle Archaic, Late Archaic, and Early Ceramic contexts. In the early Archaic there were four small endosperm which were either *Chenopodium* spp. or *Amaranthus* spp. The presence of *C. berlandieri* as early as 6500 B.P. in the Northeast in an anthropogenic environment has not been confirmed by direct dating of the seeds.

In a Middle Archaic (6320–5695 B.P.) feature at the deeply stratified Sharrow site in central Maine, a single fragment of *Cucurbita pepo* (pepo gourd) rind was preserved, in association with hawthorn, bedstraw, bramble, elderberry, and other seeds, acorn, beechnut, and tuber (not groundnut) (Petersen and Asch Sidell 1996). Even more seeds would have been recovered with flotation sampling. As early as 7300 years ago in the Midwest, the rind of pepo gourd was found in the Koster site midden in westcentral Illinois, far from the natural range of *Cucurbita pepo* (Asch and Hart 2004). Remarkably, it was carried as far east as the Sharrow site by 5695±100 B.P. (cal. 2σ 4768–4346 B.C.) and to the Memorial Park site in central Pennsylvania by 5404±552 B.P. (cal. 2σ 5467–2928 B.C.) (Hart and Asch Sidell 1997). At Memorial Park site, there were very few seeds found in the Archaic levels despite the use of flotation sampling. The Early Woodland deposits at Memorial Park site had 10 domesticated squash/pumpkin rind fragments, but only one seed of little barley, probably intrusive. At Sharrow, however, the relative abundance of seeds from fleshy fruits in the Middle Archaic (56%) as well as the gourd rind suggest there may have been extensive anthropogenic areas around the site.

Late Archaic sites in Maine, with a relatively high seed ratio despite the lack of flotation sampling, also show reliance on fleshy fruits. At the deeply stratified Brockway site (4370–3670 B.P.), located near Sharrow site in central Maine, the most common seeds from Moorehead phase (4370–4220 B.P.) features were fleshy fruits consisting of wild raisin, bunchberry, hawthorn, bramble, cherry, and elderberry. Beechnut shell was also recovered from Moorehead features. At the Hunter Farm site (4730–4160 B.P.) by the estuarine Androscoggin River, the most common plant food remains were grape, hazelnut, and acorn, including nutmeat as well as shell fragments.

EASTERN AGRICULTURAL COMPLEX AND TOBACCO

By 2000 B.P. there were six or more species of indigenous seed plants cultivated in the Midwest, including marshelder, sunflower, goosefoot, erect knotweed, maygrass, and little barley (D. Asch and N. Asch 1985a, Asch and Hart 2004). Marshelder was the first crop to be grown for food, and it was domesticated by 4000 B.P. in west-central Illinois. By then domesticated sunflower had spread eastward to Tennessee. Giant ragweed may have been an early crop in Illinois (D. Asch and N. Asch 1985b), and it was found in a cache with other crop seeds in Arkansas at 2850 B.P. (Fritz 1997). Goosefoot was domesticated after 4000 B.P., little barley became common before 2000 B.P. in Illinois, erect knotweed after 2000 B.P., and erect knotweed was domesticated by ca. 750 B.P. (D. Asch and N. Asch 1985a). These various species that made up the Eastern Agricultural Complex were sometimes grown together with maize from about 2100 B.P. until 750 B.P. in the eastern U.S., particularly in Arkansas, Missouri, Illinois, Tennessee, Kentucky, Ohio, and eastward to central Pennsylvania (Asch and Hart 2004).

Iva annua (marshelder)

Three small grains of marshelder have been reported in Ontario along with little barley and goosefoot by the Late Woodland (Crawford and Smith 2003). Marshelder does not grow naturally in the Northeast except for the coastal species *Iva frutescens* (saltmarsh-elder).

Two wild-sized *Iva annua* achenes (Table 3-4) were present at the Broome Tech site ca. 2900–2150 B.P. This Transitional occupation of the Broome Tech site in the Chenango River valley of southern New York was characterized by abundant nutshell, abundant oak and hickory wood charcoal (59%), but only 10% seeds from fleshy fruits. One of the marshelder seeds was from the Upper Transitional horizon and the other from the Lower Transitional. Significantly, other seeds found in the Transitional levels were goosefoot, giant ragweed, smartweed, and tick trefoil. This assemblage bears similarities to the list of native plants that were cultivated in the Eastern Woodlands by 2000 B.P. in the midcontinent (Asch and Hart 2004; Fritz 1990), but none of the Broome Tech seeds were from obviously domesticated plants. Perhaps also significant was the presence of three maize cupule fragments, which occurred singly in three midden samples, two from the Lower Transitional horizon and one from the Upper Transitional. However, it is assumed that the maize fragments were intrusive from overlying occupations, since there were no maize fragments found in Transitional features and since maize has not been documented before 2270 B.P. in the eastern U.S. (Hart et al. 2007).

Table 3-4. *Iva annua*, marshelder

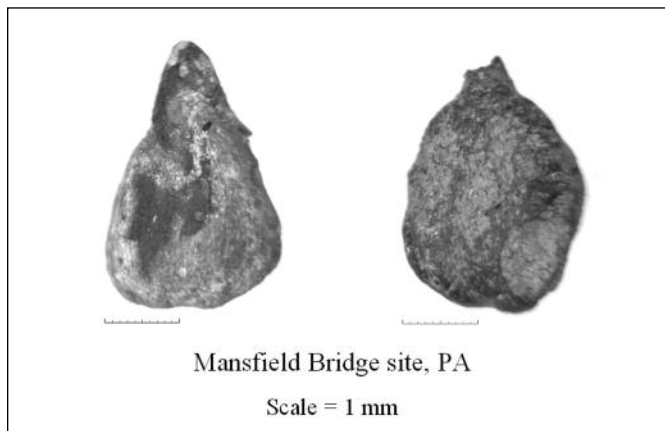
Site	Age B.P.	Kernel/ Achene	Uncorrected		Corrected		Size Index
			Length	Width	Length	Width	
Broome Tech, NY	2900–2150	kernel	1.6	1.3	2.4	1.8	4
"	"	kernel	1.65	1.6	2.4	2.3	5
Mansfield Bridge, PA	1130–940	kernel	3.8*	2.5	4.8	3.6	17
"	"	kernel	~3.6	2.4	5.1	3.4	17
"	"	kernel	-	2.7*	-	3.4	-

Note: Size in mm, corrected for 10% shrinkage and missing pericarp (* = ½ missing pericarp):

Uncarbonized achene length = $1.36 \times (\text{carbonized kernel length}) + 0.17 \text{ mm}$.

Uncarbonized achene width = $1.45 \times (\text{carbonized kernel width}) - 0.06 \text{ mm}$.

Modern wild achenes measure 2.8 mm x 2.2 mm (size index = 6) (D. Asch & N. Asch 1985a).

**Figure 3-4.** *Iva annua* var. *macrocarpa*, domesticated marshelder.

The multicomponent Mansfield Bridge site (8780–940 B.P.) in the Tioga River valley in northern Pennsylvania had an Early Owasco component (1150–940 B.P.) with domesticated marshelder (Figure 3-4). Two of the three marshelder seeds were found in a large, deep pit dating 1130±80 B.P. (cal. 2σ A.D. 700–1030) inside a sub-rectangular house. Other domesticated plants found in the household features were maize, squash, sunflower, and goosefoot. Fleshy fruits and medicinal plants included hawthorn, plum, bramble, elderberry, bedstraw, smartweed, sumac, and lily family. Nutshell was very common in both Archaic and Early Owasco levels, but the types of nuts that were utilized changed significantly through time.

Hordeum pusillum (little barley)

The most detailed record of maize grown with cultivated native seeds comes from the Clemson Island occupations at the Memorial Park site on the West Branch of the Susquehanna River in central Pennsylvania, dating 1190–860 B.P. (Table 3-3). Besides maize, the crops were little barley, two types of domesticated goosefoot, and a single seed from a small-headed sunflower (Hart and Asch Sidell 1996). The goosefoot was concentrated in the Early and Late Clemson Island, the sunflower in the Early

Clemson Island, and the little barley occurred throughout Early, Middle, and Late Clemson Island as well as Stewart Phase (660–565 B.P.) components. A single tobacco seed was found in an undated Late Woodland feature. Other seeds of interest included black nightshade, wild rice, amaranth, huckleberry, blueberry, elderberry, sumac, pin cherry, and several types of grass including barnyard grass and panic grass.

Chenopodium berlandieri (goosefoot)

Goosefoot seeds were found in 15 of the 36 occupations with maize in this study, and domesticated *C. berlandieri* ssp. *jonesianum* was positively identified at four of those sites (Table 3-5). Goosefoot was also identified at numerous pre-maize sites in Maine and New York. The goosefoot found at most archaeological sites in the Northeast has seed coats that are thinner than those for wild mid-western and southeastern populations of *C. berlandieri* described by Smith (1992) as 40–80 μm thick. Archaic seeds from the Northeast measure 15–65 μm thick, with the 15 μm measurement coming from an immature or late season seed. Late Archaic to Late Woodland seeds tend to be 20–50 μm thick, excluding obviously truncate seeds and immature seeds. At the sites in northern Pennsylvania and in southcentral New York that have goosefoot with truncate margins and very thin seed coats, obviously domesticated forms, there are round/biconvex-margined seeds with thicker coats in the same contexts (Table 3-5). The seeds with thicker coats may have grown as a weed in the maize or cultivated goosefoot fields and in disturbed soil around the villages, and the seeds could represent a food that was used to supplement the maize supply. Gremillion (1993) suggests that frequent occurrence of weed forms late in prehistory may represent a decline in subsistence importance, but that observation may not apply to these northeastern sites where evidence of pre-maize cultivation of domesticated goosefoot is lacking.

At the Memorial Park site in Pennsylvania, domesticated goosefoot with truncate margin and thin seed coat (testa) was found in the Early Clemson Island component (1190–1120 B.P.), but most of the measurable seeds resem-

Table 3-5. *Chenopodium berlandieri*, goosefoot.

Site	Age (B.P.)	Mean diameter (mm)	Range (mm)	Mean testa thickness (microns)	Range (microns)	Margin	No. seeds measured
Ntolonapemk, ME	6460–6470	1.4	-	45	-	?	1
"	5840–3990	1.4	-	?	[15]-65	?	2
"	2490–520	1.4	-	29	22-35	?	3
Hunter Farm, ME	4730–4160	1.6	-	thick	-	?	1
Broome Tech, NY	2900–2150	1.45	1.3-1.6	38	25-50	rounded/ biconvex	13
Glidden Mound, ME	2200–1500	1.58	1.5-1.7	40	40	rounded	6
Tranquility Farm, ME	1280	1.36	1.2-1.5	?	?	rounded/biconvex	8
Deposit Airport I, NY	1250–750	1.52	1.4-1.65	32	20-40	rounded/ biconvex	13
"	"	"	[~1.2]	~[16]	-	truncate	1
Memorial Park, PA	1190–1120	1.8	-	thin	-	truncate	1
"	"	1.73	1.5-2.1	absent	-	truncate	8
Mansfield Bridge, PA	1130–940	1.61	1.55-1.65	32	21-35	biconvex	5
"	"	1.81	1.7-2.0	15	7-28	truncate	9
Lindesay, NY	950–500	~1.4	-	-	-	-	2
Scudder, NY	950–650	1.5	1.4-1.6	44	44	rounded/biconvex	2
"	"	-	-	26	22-29	truncate?	2
Headquarters, VT	840–410	1.49	1.36-1.56	37	25-50	rounded	10
294A-25-2	790–220	1.5	-	very thin	-	?	1
Thomas/Luckey, NY	650–500	1.20	.95-1.70	21	8-40	various	26
Ripley, NY	650–300	1.47	1.35-1.7	35	25-40	rounded/ biconvex	8
Bailey, NY	550–290	1.42	1.25-1.7	44	37-58	rounded/ biconvex	11
Tracy Farm, ME	~450	1.55	1.5-1.6	40	36.5-44	rounded/ biconvex	2
"	335–255	1.52	1.3-1.7	34	20-40	rounded	20
Norridgewock Mission, ME	255–200	1.49	1.3-1.7	28	14.5-36.5	rounded/ biconvex	30

Note: According to Smith (1992), wild-type *C. berlandieri* seed coats are 40-80 microns thick, based on measurements of wild populations from the Midwest and Southeast; domesticated seeds typically have a truncate margin and testa thickness in the range of 9-21 microns. [] = immature seed

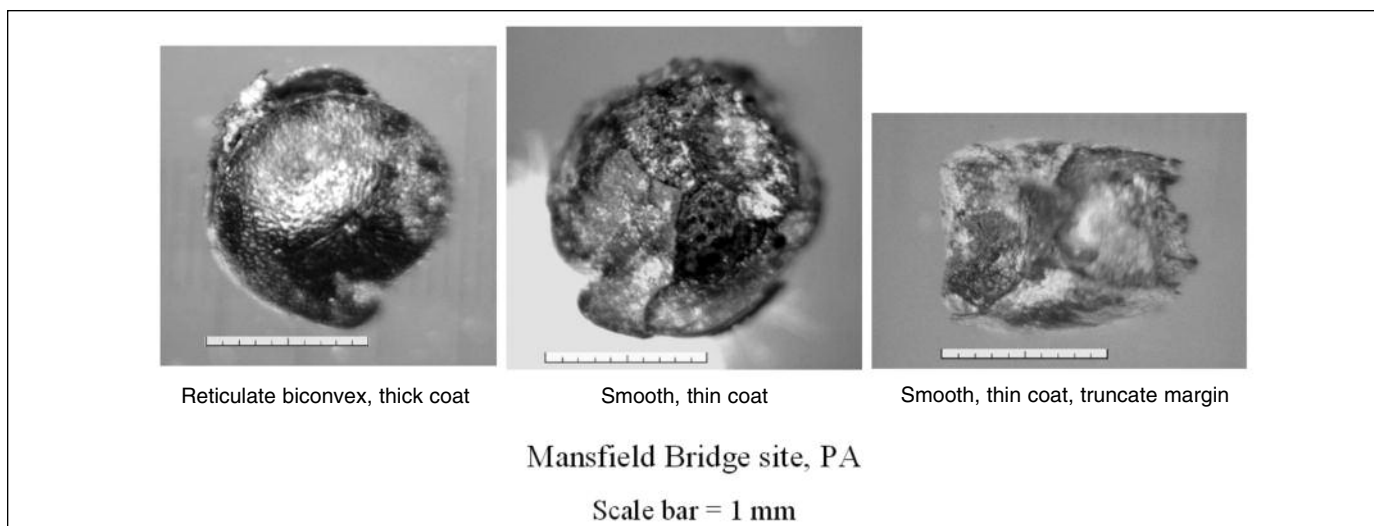


Figure 3-5. *Chenopodium berlandieri*, Mansfield Bridge site.

bled the Mexican cultigen huauzontle, in which the outer epiderm is entirely absent. That type of pale-seeded *C. berlandieri* also was found in a Late Clemson Island component (900–860 B.P.) feature (Hart and Asch Sidell 1996).

At Mansfield Bridge site, Pennsylvania, the goosefoot was concentrated in a circular pit within a sub-rectangular house feature. Most of the 291 seeds consisted of popped endosperm with the seed coat missing. Among the 38 popped seeds retaining all or part of the seed coat, the seeds were clearly of two types. One type was reticu-

late with rounded to biconvex edges that tended to split along the margin, a wild/weed seed. The second type of seed was slightly larger in diameter with a thin smooth coat that formed a truncate margin, definitely a domesticated (Figure 3-5).

Deposit Airport I site, located in the floodplain of the West Branch of the Delaware River, New York, was occupied ca. 1250–500 B.P. Goosefoot seeds exhibited variation in seed surface, testa thickness, and margin shape. Seeds indistinguishable from wild/weed type had a reticulate

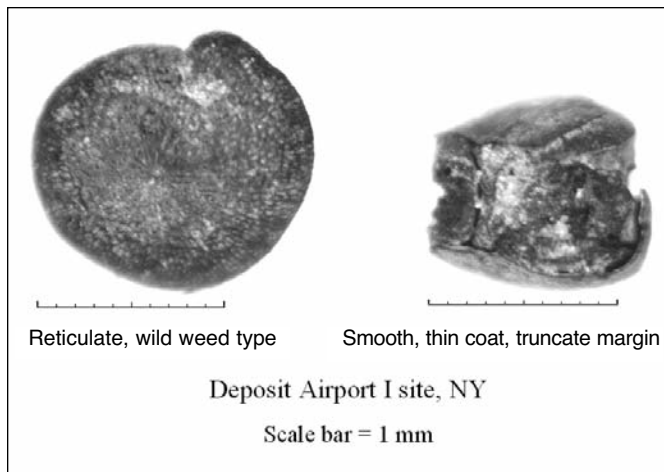


Figure 3-6. *Chenopodium berlandieri*, Deposit Airport I site.

testa that tended to split in half around the biconvex to rounded margin (Figure 3-6). Another type with thinner seed coats ($24\text{--}35\text{ }\mu\text{m}$) was represented by popped endosperm with small areas of smoother, fragile testa attached. One seed had the truncate margin and very thin ($16\text{ }\mu\text{m}$) testa characteristic of domesticated goosefoot. This site represents the easternmost occurrence of domesticated *C. berlandieri*. The goosefoot was present in 6 out of 30 features, the same number of features that contained maize. Goosefoot was associated with maize in two features and with cucurbit rind in one feature. Besides a low density of maize, Deposit Airport I site also had abundant seeds including 41% seeds from fleshy fruits (bramble, blueberry, huckleberry, and hawthorn); 50% oak, hickory, and chestnut wood charcoal; and abundant nutshell of all types—hickory, acorn, butternut, chestnut, bitternut hickory, beechnut, and hazelnut.

At Scudder site, a small village (950–650 B.P.) located at the confluence of Canisteo and Tioga rivers in New York, *C. berlandieri* was found in two features. Feature 3 contained one endosperm and two measurable seeds that are wild/weed type (Table 3-5, Figure 3-7). Feature 5 contained two endosperm with small fragments of fairly thin ($22\text{--}29\text{ }\mu\text{m}$) seed coat attached. These two seeds resembled domesticated seeds in the way that the seed coat had shattered, rather than breaking along the margin (Figure 3-7).

One small pit feature at Thomas/Luckey site (650–500 B.P.) in the floodplain of the Chemung River in New York contained an unusual assortment of 29 *C. berlandieri* seeds. The seeds varied widely in size, with the majority of seeds smaller than modern wild type seeds and with seed coats mostly thinner than wild type seeds. Overall, the seeds do not appear to be a domesticated variety because the largest seeds have a biconvex to rounded margin rather than a truncate margin. Since many of the seeds at Thomas/Luckey appeared to be immature

and/or to lack an endosperm, it is possible that these seeds are the remains of discarded chaff from winnowing. Maize was abundant and ubiquitous at Thomas/Luckey site, occurring in 37 of the 38 samples examined, and beans were also grown. Half of the seeds at this site were grass seeds found in a storage pit lining. In the pit lining, there were 306 big bluestem seeds, three wild rye, two other tiny grass seeds, 174 beans, one hawthorn, one huckleberry, and one smartweed.

There was a large collection of *C. berlandieri* found in the Late Woodland component (840–410 B.P.) at the stratified Headquarters site, east of Lake Champlain on the southern bank of the Missisquoi River. In one feature there was a minimum number of 400 goosefoot, composed of 204 endosperm lacking seed coat, 80 shell fragments with beak area, 46 popped seeds, 64 not popped, 65 immature, and 19 with insect holes. Measurement of 10 popped seeds at 200x yielded a mean diameter of 1.49 mm (range 1.36–1.56) with a testa thickness of $37\text{ }\mu\text{m}$ (range $25\text{--}50\text{ }\mu\text{m}$). This appears to represent a typical wild-type population of *C. berlandieri* in the Northeast.

The goosefoot that has been found at pre-maize sites in northern New England dating back to about 6500 B.P. must represent plants that grew on disturbed soil around settlements. *C. berlandieri* is considered very rare in Maine today (Haines and Vining 1998:362), and has not been identified in the northern tier of counties (Campbell et al. 1995). Modern *C. berlandieri* has not been documented from the county containing the Norridgewock Village sites (530–190 B.P.) where it grew during the late Woodland/Contact period. *C. berlandieri* var. *macrocalycium* is a plant of coastal areas and sea beaches, var. *bushmanum* is a plant of cultivated ground and disturbed soil, and var. *boscianum* has been found in disturbed soil in only three counties. In terms of seed size, var. *macrocalycium* measures 1.3–1.7 mm in diameter, whereas var. *bushmanum* is mostly 1.5–2.0 mm wide (Haines and Vining 1998).

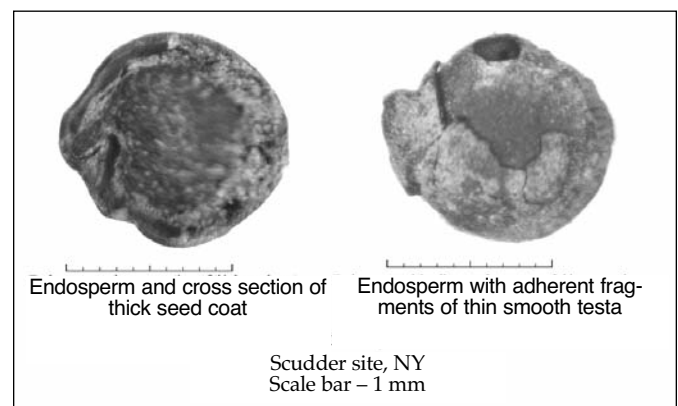


Figure 3-7. *Chenopodium berlandieri*, Scudder site.

Helianthus annuus (common sunflower)

In this study, 11 of the 36 occupations with maize also contained ruderal or domesticated sunflower, usually a single kernel or achene per site. There was also one sunflower from a Vermont site that did not have maize. This stands in contrast to the large amount of sunflower found at Ontario sites in association with maize. Yarnell (1978:291) suggests that wild sunflower achenes probably measure 4.5–5.0 mm in length, modern ruderal achene length is 4.0–7.0 mm, and cultivated achenes range from about 6 mm to more than 20 mm. Based on Yarnell's criteria, domesticated sunflower seeds were recovered from five sites in this study including Mansfield Bridge, Pennsylvania (1150–940 B.P.), and four New York sites: Thomas/Luckey (650–500 B.P.), Ripley (650–300 B.P.), Plus (554–450 B.P.), and Bailey (550–290 B.P.) (Table 3-6, Figure 3-8). The sites with probable ruderal sunflower were Memorial Park, Pennsylvania (1130–940 B.P.); Porcupine, Vermont (1890–250 B.P.); Tracy Farm, Maine (350–250 B.P.); and three New York sites: Lamb (1150–650 B.P.), Park Creek (1050–400 B.P.), and Scudder (950–650 B.P.). The Ripley site and Early Fall site (570–460 B.P.) had small possible sunflower about 3.4 mm in length (Figure 3-9). At Early Fall site in Maine, the tiny seed in question was found in association with maize, squash rind, bean, hazelnut, acorn, bramble, sumac, elderberry, pin cherry, grape, bristly sarsaparilla, bunchberry, *Chenopodium* spp., and other seeds. A Contact feature at Tracy Farm site in Maine had a possible ruderal sunflower seed in association with maize, squash rind, wild rye, and tick trefoil seeds.

The Ripley site had one tiny partial sunflower achene, one broken kernel, and one intact kernel (Figures 3-8, 3-9).

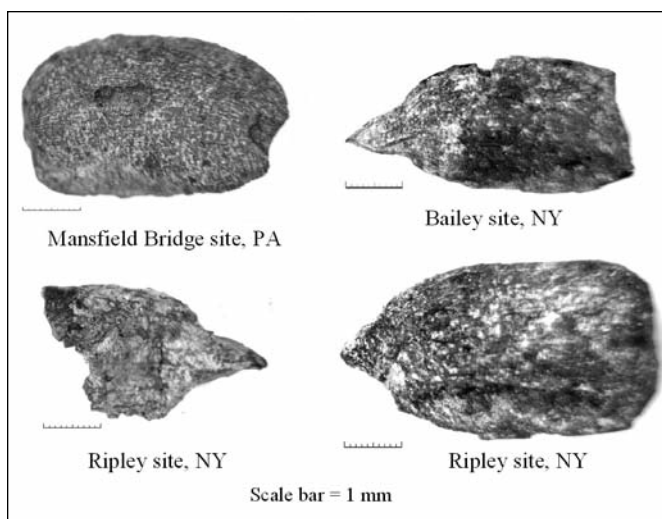


Figure 3-8. *Helianthus annuus* var. *macrocarpus*, domesticated sunflower

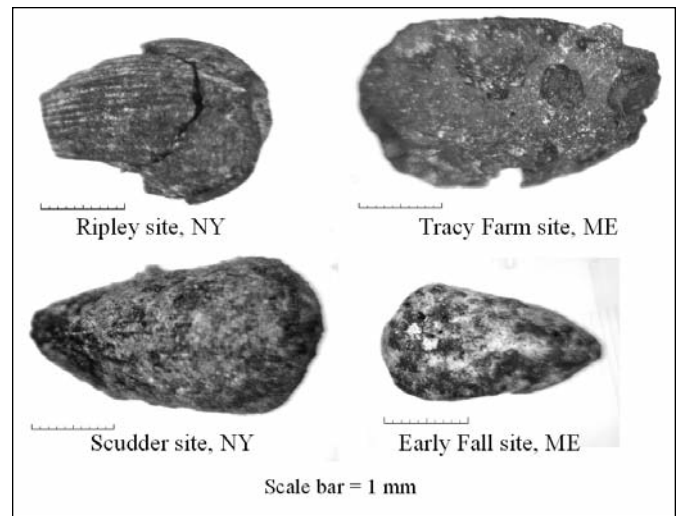


Figure 3-9. *Helianthus* spp., wild/ruderal sunflower

The two kernels fit within the size range of small cultigen sunflower achenes generally found at Ontario and New England sites (Crawford and Smith 2003). The achene, however, was smaller than the proposed size range for the ruderal form of the common sunflower, *Helianthus annuus*. Other possibilities, which remain to be considered, are that the seed is a wild *H. divaricatus* (rough or woodland sunflower), which is common in dry woodlands, in thickets, and on banks (House 1924); *H. decapetalus* (thin-leaved sunflower), which grows in moist woods and along streams; or *H. strumosus* (pale-leaved wood sunflower), growing in dry soil and on banks. The root of the latter species was used by the Iroquois as a medicinal plant (Moerman 1998:259).

Crawford and Smith (2004) show that achene sizes in Ontario are smaller than expected from a comparison with seeds grown in the Midwest; they also document a latitudinal gradient in sunflower achene size with decreasing achene size to the north. They suggest the northeastern sunflower may be a small-seeded variety of *Helianthus annuus*. It has been proposed that the Northeast may also differ from the Midwest in how the sunflower was utilized, primarily for ritual uses rather than food (Bodner 1999). The measurement of sunflower seeds from throughout the Northeast shows that many of the seeds may have been from branched plants with multiple heads.

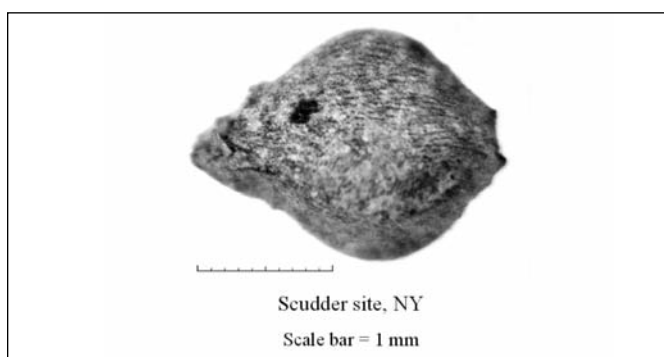
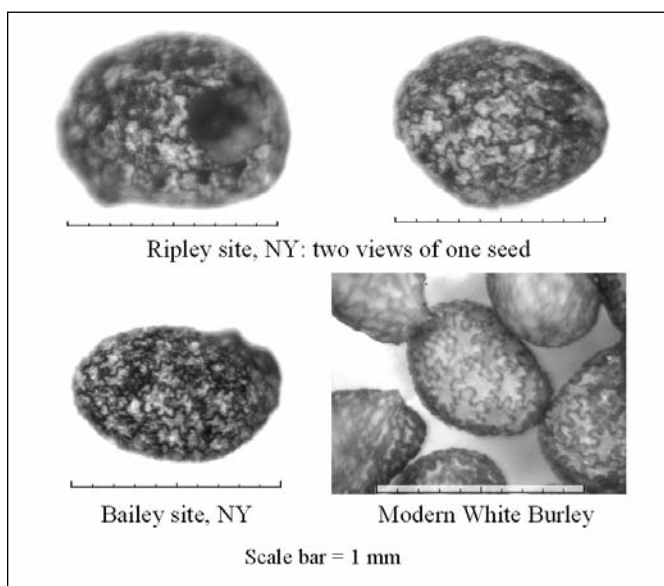
Polygonum erectum (erect knotweed)

Scudder site in New York (950–650 B.P.) is the first site in the Northeast (exclusive of Ontario) where erect knotweed has been identified. Erect knotweed was cultivated after about 2000 B.P. and eventually domesticated in the midwestern U.S. The Scudder achene (Figure 3-10) measured 2.4 x 1.8 mm, uncorrected for 20% shrinkage,

Table 3-6. *Helianthus* spp., sunflower

Site	Age B.P.	Kernel/ Achene	Uncorrected		Corrected		Size Index
Porcupine, VT	1890–250	kernel	3.0	1.8	3.9	2.6	10
Memorial Park, PA	1190–1120	kernel	3.9	1.7	5.1	2.5	13
Lamb, NY	1150–650	achene	3.9	1.7	4.3	2.2	9
Mansfield Bridge, PA	1130–940	achene	5.2	3.2	5.8	4.1	24
Park Creek II, NY	1050–400	achene	3.8	2.5	4.2	3.2	13
Scudder, NY	950–650	achene	3.75	2	4.2	2.5	11
Thomas/Luckey, NY	650–500	kernel+	7.3	3.2	9.5	4.4	42
"	"	kernel	>5.9	3.1	>7.7	4.5	>35
Ripley, NY	650v300	achene	2.85+	2.0	~3.4	2.5	9
"	"	kernel	>>4.1	2.5	>>5.3	3.6	>>19
"	"	kernel	5.8	3.3	7.5	4.8	36
Early Fall, ME	570–460	kernel?	2.6	1.4	3.4	2.0	7
Plus, NY	550–450	achene	6.6	3.1	7.3	3.9	28
Bailey, NY	550–290	kernel	>5.2	2.7	>6.8	3.9	>27
Tracy Farm, ME	350–250	achene	>3.8	2.2	>4.2	2.8	>12

Note: Yarnell (1978) suggests that wild sunflower achenes measure 4.5–5.0 mm in length, modern ruderal achene length is 4.0–7.0 mm, and cultivated achenes range from 6 mm to more than 20 mm. Size in mm, corrected for shrinkage and missing pericarp by increasing achene length and width by 11% and 27%, respectively; increasing kernel length and width by 30% and 45% (or more), respectively (Yarnell 1978 method). + = the pericarp layer was missing on one end of the achene.

**Figure 3-10.** *Polygonum erectum*, erect knotweed, early season phenotype**Figure 3-11.** *Nicotiana* spp., tobacco

and it had the striate-punctulate surface of an early season wild type seed (N. Asch and D. Asch 1985). Erect knotweed grows in moist or dry soil and is locally common as a weed in waste or cultivated ground throughout most sections of New York today. House (1924) mistakenly identified it as a native of Europe.

Nicotiana rustica (tobacco)

Outside of Ontario, tobacco seeds are rarely found at sites in the Northeast. In the beech–maple forest region immediately south of Lake Erie and Lake Ontario in New York, a single carbonized tobacco seed was recently identified from the Bailey site (550–290 B.P.) and a single tobacco seed from Ripley site (650–300 B.P.) (Figure 3-11) (Asch Sidell 2004c, 2006d). The tobacco seeds previously reported by Bodner (1989) for the Ripley site were actually blueberry seeds (Asch Sidell 2006d). One tobacco seed has been identified in Late Woodland deposits at the Memorial Park site in central Pennsylvania, but not in the samples specifically assigned to Owasco or Stewart components (Hart and Asch Sidell 1996). No tobacco seeds have been recovered from New England where it is known to have been grown during the Contact period.

CHANGES IN FOREST COMPOSITION

On the Cumberland Plateau in eastern Kentucky, Delcourt et al. (1998) documented an increase in charcoal accumulation rates and in fire-tolerant oaks, chestnut, and pines in pollen diagrams after 3000 B.P. that coincided with human occupation of rockshelters and cultivation of native plants. In southcentral New York and northcentral Pennsylvania, there is evidence both from wood char-

coal and food remains that human activities altered the natural vegetation through time at some locations. Three sites that have both maize and early pre-maize occupations for comparison are the Memorial Park site in central Pennsylvania, the Mansfield Bridge site in northernmost Pennsylvania, and the Broome Tech site in southern New York.

Memorial Park

The Memorial Park site is located in the Susquehanna River valley at the demarcation line between the northern hardwoods and the oak–chestnut forest zone. An increase in the percentage of oak and hickory wood charcoal and in seed density is associated with the presence of maize agriculture and the growing of some species of the Eastern Agricultural Complex (Table 3-2). Two-thirds of the Late Woodland (1190–565 B.P.) seeds were from cultivated plants, including little barley, two domesticated forms of goosefoot, one sunflower kernel, and one tobacco. The increase in oak and hickory wood charcoal in the Early Clemson Island (1190–1120 B.P.) was accompanied by an increase in the variety of nuts utilized (all seven types that were available), the seed index (to 2.12 seeds per g of charcoal from 0.03 in the Early Woodland [3095–2830 B.P.]), and in the variety of seeds (16 types vs. one type in the Early Woodland), indicating more open habitat for seed and fruit collection in the Late Woodland occupations.

Mansfield Bridge

Mansfield Bridge is a multicomponent site located in the Tioga River valley in northern Pennsylvania. Analysis of plant remains focused on 17 Middle Archaic and Terminal Archaic features (ca. 8780 to 4440 B.P.), and 18 features from an early Owasco household and ceramic vessel construction area, with several dates falling in the range of 1150 to 1130 B.P. Mansfield Bridge site is the first Owasco site to provide good evidence that maize and seeds of the Eastern Agricultural Complex as well as squash/pumpkin were grown together in northernmost Pennsylvania and, therefore, perhaps also in southern New York state.

At Mansfield Bridge site, both the Archaic and early Owasco levels were dominated by species of the hemlock–white pine–northern hardwoods forest. Hickory wood and hickory nutshell were absent from the Archaic samples. Floodplain and bottomland tree species were slightly more abundant in the Archaic than in early Owasco, as were species characteristic of disturbed woods or thickets, such as cherry, hawthorn, and poplar. However, the very low density of seeds in the Archaic may indicate that there were few openings near the site for growth of weeds and thickets. In the early Owasco, seeds of plum, hawthorn, bramble, and sumac indicate

that there were areas of secondary succession near the site that were not reflected in the wood charcoal.

Nutshell of various types made up a relatively large proportion of the plant remains, 15% in the Archaic and 8% in the early Owasco. Nutshell was ubiquitous and abundant in all occupations, although the types of nutshell in the Archaic (mostly butternut and hazelnut) were different from those in the early Owasco (hickory, chestnut, acorn, beechnut, and bitternut hickory). Butternut is a locally abundant species that tends to grow in rich or rocky woods along streams. The presence of butternut shell in the Archaic and its virtual absence in the early Owasco may mean that the butternut grove was cleared for the planting of crops or that it may have died out if fire was used to clear an area for planting crops, both maize and native domesticated seed plants. The use of fire would favor hickory, oak, and chestnut trees, and all of those nut types appeared in the Owasco samples.

The seed assemblage in the early Owasco occupation at Mansfield Bridge site was dominated by domesticated species and fleshy fruits, especially hawthorn, which was found in 7 of the 13 house features. There was one domesticated sunflower achene, three domesticated marshelder seeds, and two phenotypes of goosefoot, one of which was clearly domesticated. Unexpectedly, there were no grass seeds. Maize field weeds were also lacking, unless some of the goosefoot seeds were from weedy plants. Three of the seven *Polygonum* (smartweed) seeds were probably *P. scandens* (false buckwheat), a species that may have been tolerated or even encouraged as a source of edible seeds at some Clemson Island sites in Pennsylvania. At Site 36Ti58 in central Pennsylvania, *P. scandens* was more abundant and ubiquitous than any of the native seed crops other than *Chenopodium* during the Clemson Island phase (1050–650 B.P.) (Gardner 1993).

Broome Tech

At Broome Tech site in the wide floodplain of the Chenango River in southern New York, there was an increase in the percentage of oak, hickory, and chestnut wood charcoal that coincided with maize agriculture (Table 3-2). The Transitional (2900–2150 B.P.) and Late Woodland (Owasco: 950–700 B.P.) occupations at Broome Tech had a high percentage of oak and hickory wood charcoal (as well as chestnut in the Late Woodland) and those occupations also had a high nutshell index composed of hickory nut, butternut, acorn, bitternut hickory, and hazelnut. In contrast, the Middle Woodland (1960–1050 B.P.) occupation at Broome Tech had a much higher percentage of beech and maple wood charcoal, with a very low nutshell index. That was the only occupation with beechnut shell, which comprised 73% of the Middle Woodland nutshell.

The Early Woodland abundance of oak and hickory

charcoal was associated with a seed assemblage dominated by weedy species that can be of economic importance — giant ragweed, goosefoot, tick trefoil, marshelder, and false buckwheat. Although similar species were cultivated and collected in other parts of the eastern U.S. at that time, none of the Broome Tech seeds were obviously domesticated varieties. However, it seems significant that there were two achenes of *Iva annua* identified, yet there are no species of marshelder that are native to southcentral New York. If the Early Woodland occupation at Broome Tech is interpreted as having engaged in growing some native plants, perhaps with the accompanying use of fire to keep the landscape open, then frequent burning could have led to elimination of northern trees that are intolerant of fire, such as beech, hemlock, sugar maple, black birch, and even white pine. They are replaced by trees that can sprout from the roots, such as chestnuts, oaks, and hickories (Cronon 1983). Presumably occupation and burning of the site ceased for a period of time prior to the Middle Woodland settlement, long enough for the shade tolerant (and fire intolerant) beech and sugar maple to fill in the gaps in the hypothesized oak-hickory woodland. During the Late Woodland occupation, with the presence of maize agriculture, there was a return to dominance by oak and hickory wood charcoal with an admixture of many other species. The nutshell assemblage was again dominated by butternut and hickory as in the Early Woodland levels, and the overall percentage of nutshell as well as nutshell density increased above Middle Woodland levels. With the opening up of the landscape for agriculture, seed density also increased. About half of the Late Woodland seeds were from fleshy fruits, including hawthorn, strawberry, blackberry/raspberry, elderberry, and possibly blueberry, but there were few seeds of the economically important weeds and/or cultivated seed plants identified in the Early Woodland at Broom Tech.

Other Bottomland Sites

Many floodplain locations in southcentral New York may have elevated oak-hickory-chestnut wood charcoal levels in the Late Woodland due to maize agriculture, but the sites lack earlier occupations for comparison. Those sites are Apalachin Creek (1050–850 B.P., 50% oak-hickory-chestnut), Thomas Creek site (1150–650 B.P., 62%), Deposit Airport I site (1250–750 B.P., 50%), and Horseheads site (1050–450 B.P., 73%). The use of fire to alter vegetation at bottomland sites was also proposed for the Late Woodland Lamb site (1150–650 B.P.), which had a unique abundance of wood, bark, cone scales, and needles from pitch pine, a fire tolerant species seldom found in abundance in floodplain locations. At Scudder site (950–650 B.P.), the wood charcoal assemblage unexpectedly was also dominated by pine wood, probably white

pine. Braun's (1950) maps of New York suggest the Scudder site might have been located on a chestnut-oak-hickory terrace or in a floodplain forest at the confluence of the Canisteo and Tioga rivers. However, the archeobotanical analysis of wood charcoal, nut, seed, and cultigen remains suggested the environment around the site was quite different from Braun's model. The Scudder site is located in a bottomland, yet only 5% of the wood charcoal was from bottomland species and 6% was from species indicative of human disturbance. The abundant pine wood (81%) in all contexts and white pine needles in one feature were apparently not part of an upland beech-maple-birch-pine-hemlock forest, because only the pine component was represented. One possibility is that the floodplain and terrace forest may have been cleared for agriculture and the pine may have been present as a successional species in previously abandoned maize fields.

CONCLUSIONS

In this chapter the impact of maize-based agriculture on annual and perennial herbaceous plants and on woody plant communities was examined first of all by demonstrating the ubiquity of maize-based agriculture in the Northeast from central Maine to central Pennsylvania and New Jersey. Then by considering the relationship between wood charcoal and forest region, nutshell and nut trees, and seed use through time at 58 sites with 85 components, a clearer picture emerged of the impact of maize agriculture in the various forest regions.

1. The most significant finding was that maize was present at all but two of 33 sites with 38 components postdating about 1190 B.P., regardless of the size or function of the sites. The sites were essentially selected at random by the nature of my work as a subcontractor to numerous state and private agencies, universities, and individuals. The two sites without maize were inadequately sampled.
2. Cultivation of native seed plants co-occurred with maize in central Pennsylvania, northcentral Pennsylvania and southcentral New York. Little barley (*Hordeum pusillum*) was grown at Memorial Park site, Pennsylvania in components dating between 1190 and 565 B.P., along with two types of domesticated goosefoot (*Chenopodium berlandieri* ssp. *jonesianum*), ruderal sunflower, and tobacco. In northcentral Pennsylvania, domesticated marshelder (*Iva annua* var. *macrocarpa*), domesticated sunflower (*Helianthus annuus* var. *macrocarpus*), domesticated goosefoot, and pepo gourd/squash were grown between 1150 and 940 B.P. at Mansfield Bridge site in the floodplain of the Tioga River. In

southcentral New York, domesticated goosefoot was found with maize at Scudder site (950–650 B.P.), located about 45 km downstream from (north of) Mansfield Bridge at the confluence of Canisteo and Tioga rivers. The easternmost occurrence of domesticated goosefoot with maize was at Deposit Airport I site (1250–750 B.P.) in the floodplain of the West Branch of the upper Delaware River of New York, approximately 15 km east of the Susquehanna River.

3. Both domesticated goosefoot and wild/weed-type goosefoot seeds occurred together at Mansfield Bridge site in Pennsylvania, and Deposit Airport I and Scudder sites in New York. At Mansfield Bridge, the goosefoot occurred with domesticated sunflower and domesticated marshelder, but at Scudder, the sunflower seed was wild/ruderal sized. Both wild/weed-type *C. berlandieri* and barely discernible amounts of ruderal sunflower (or a small-seeded cultivar) spread throughout the Northeast with the spread of maize agriculture, but goosefoot was already present in anthropogenic plant communities in Maine dating back to ca. 6500 B.P. (Table 3-3). Cucurbit and tobacco remains were scarce in the archaeological record during Late Woodland/Protohistoric times (Table 3-3).
4. In the New England section of the hemlock–white pine–northern hardwoods forest region, there is a long history of plant use dating back to Paleoindian in Maine. Sites occupied prior to ca. 4200 B.P. had a high percentage of fleshy fruits and a relatively high seed index reflecting an anthropogenic environment despite the lack of flotation sampling in some cases. During this time, pepo gourd was imported (ca. 5695 B.P.), presumably from the central U.S. where it was cultivated, and pepo gourd may have been propagated in central Maine. Six pre-maize occupations from four sites in Maine also had *C. berlandieri* among the seed remains, indicating that the presence of goosefoot at sites in the Northeast is related to anthropogenic activities rather than the growing of maize. The earliest occurrence of *C. berlandieri* was at Ntolonapemk site in eastern Maine in the Middle Archaic occupation (6460–6470 B.P.). Sites occupied after 1000 B.P. in Maine had an elevated seed index and increased variety of species relating to the practice of maize agriculture.
5. Most samples of archaeological wood charcoal consisted of a mixture of species that appeared to have been randomly collected for firewood. The proportion of each wood type varied between forest regions, and between bottomland and upland sites. For example, sites in the oak–chestnut region tend-

ed to have a far higher percentage of wood from oak, hickory, and chestnut trees than did sites located in the New England and Piedmont sections of the hemlock–white pine–northern hardwoods forest region. Sites in the river valleys of southern New York and northcentral Pennsylvania generally had a higher proportion of oak, hickory, and chestnut trees, as well as floodplain species, than did the Piedmont upland locations. This could be because of migration of southern species up the major river valleys (Braun 1950). It could also be related to burning of the bottomlands to clear forest for maize fields.

6. The amount of nutshell at most sites was roughly proportional to the percentage of oak, hickory, and chestnut wood charcoal at the site. This observation, together with the wide diversity of nutshell types identified at most sites, is interpreted to mean that nut resources were used for food whenever they were available near a site, whether or not maize was grown.
7. In southcentral New York, the upland vegetation from the Late Archaic to the Late Woodland was a rich mosaic of white pine and northern hardwoods (beech, sugar maple, birch) intermixed with some nut trees (chestnut, red oak, white oak, shagbark hickory, bitternut hickory, butternut) and understory trees (hophornbeam). In contrast, some Late Woodland sites in bottomland locations had a much higher percentage of wood charcoal from oak, hickory, and chestnut trees.

Based on a sequence of occupations at Broome Tech, it was hypothesized that fire may have been used to keep the floodplain terrace forests open for optimum mast production and easier hunting (and perhaps for growing native seeds crops) during the Transitional occupation (2900–2150 B.P.), but the landscape reverted to the regional climax (mixed northern hardwoods–white pine–hemlock) before the early Middle Woodland (1960–1050 B.P.) occupation (Asch Sidell 2002g). This was supported by a change in wood charcoal species and in the types of nuts collected (beechnut in the early Middle Woodland). Then, with the opening up of fields for maize agriculture during the Late Woodland (950–700 B.P.), the oak and hickory trees, which are tolerant of repeated burning, may have been selectively left to produce mast or the renewed use of fire may have effected the change. The Broome Tech site demonstrated the necessity of doing intensive investigations at stratified sites where differences in plant use can be traced through time at the same location. As noted earlier, many floodplain locations in southcentral New York and northern Pennsylvania may have elevated oak–hickory–chestnut wood charcoal levels in the Late

Woodland due to maize agriculture, but the sites lack earlier occupations for comparison.

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END NOTES

¹ Only plant remains that were analyzed by Asch Sidell are included in this study in order to control for any variation that might be attributed to different analytical methods.

² The maize density is based on number of fragments larger than 2 mm per gram of total charcoal rather than per liter of soil. For many sites, the volume of flotation samples was not readily available. The use of an index based on charcoal weight rather than soil volume eliminates differences that may relate to excavation technique, such as selection of charcoal concentrations as opposed to random sampling within cultural horizons.

³ The term "smartweed" is used to refer to *Polygonum* spp. in Section *Persicaria*, characterized by lenticular or trigonous achenes. "Knotweed" is used to refer to *Polygonum* spp. in Section *Polygonum* (*Avicularia*), characterized by mostly or all trigonous achenes, usually unequally trigonous, that may be larger and different in shape and texture later in the season (Gleason & Cronquist 1991).

⁴ Early explorers often commented on the abundance of grape vines in New England. Pierre Biard, in 1616, described grape vines in his travels along the Maine coast and eastern Canada:

In several places we found the grape, and wild vines which ripened in their season. It was not the best ground where we found them, being full of sand and gravel, like that of Bordeaux. There are a great many of these vines at St. John River, in 46° of latitude, where are to be seen also many walnut and hazel trees, and yet the under layer of soil is not good there. (Biard 1959)

The walnut trees would have been butternut, also known as white walnut, which grow along the St. John River valley in Canada, disjunct from the continuous range of butternut which extends into southwestern Maine (Little 1971). It is interesting that the grape vines in eastern Canada apparently grow on sand and gravel, as would have been the case at Hedden 10,500 years ago.

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CHAPTER 4

SO LITTLE MAIZE, SO MUCH TIME: UNDERSTANDING MAIZE ADOPTION IN NEW ENGLAND

by *Elizabeth S. Chilton*

New England archaeologists have pondered and debated the role of maize horticulture in the region for decades, more so since John Hart first organized the session that we are commemorating here (Hart 1999a). At the heart of the so-called maize debate is a general disagreement over how to interpret the evidence at hand. Certainly, most New England archaeologists agree that we need more data on settlement patterns, more and more careful flotation, and both better methods and better funding for archaeobotanical analysis and radiocarbon dating. However, before we assess what we need for the future, it is important to first assess the data we have at hand. It is here that agreement among New England archaeologists break down. The debate is often framed by dichotomous reasoning centered on whether or not New England Algonquian were sedentary farmers prior to European Contact. Rather than summarize the maize debate, as I have done elsewhere (Chilton 2006, 2002, and 1999), in this chapter I outline recent developments in New England maize research. In doing so, my goal is to highlight what I think are the key aspects and important applications of this research.

"TOWNS THEY HAVE NONE"

When I began my research in the Connecticut River valley in the late 1980s, I was primarily interested in the Late Woodland and Contact periods (ca. A.D. 1000–1700). I had previously worked exclusively in upstate New York, and my assumption was that, through fieldwork, we would find large or at least well-defined villages, similar to what I had experienced in the Mohawk drainage (see Snow 1995). At that time I was working with Arthur Keene, Eric Johnson, and others on the University of Massachusetts Archaeological Field School. We were seeking to "tell a different story" (Keene and Chilton

1995) of the Contact Period, one that emphasized resistance instead of accommodation, and one that "illuminated histories silences" (Handsman 1991). Our aim was to "to write a history that emphasize[d] Native American actions, initiatives, and variation in resisting, accommodating and initiating change" (Keene and Chilton 1995).

As part of that project, in 1989 we excavated portions of two contact period sites and one pre-Contact site in the Connecticut River Valley. In beginning the background research for this project, I was surprised to discover that there were relatively few Late Woodland period sites known in the middle (Massachusetts portion) Connecticut River valley. From my experience working on pre-Contact Iroquoian sites, my assumption was that archaeologists had just been looking in the wrong place or that these sites had been destroyed or buried, as Hasenstab (1999) argues.

Excavations at the Pine Hill site in Deerfield, Massachusetts, challenged these assumptions (Chilton et al. 2000). Pine Hill was—and still is—the largest Late Woodland period site professionally excavated in the middle Connecticut River valley, and radiocarbon dating suggests that the main use of the site was between ca. A.D. 1400 and A.D. 1600 (Chilton et al. 2000). Portions of the site were excavated as part of the University of Massachusetts Archaeological Field School, every other summer from 1989 to 1997. Over those years, we identified 21 storage or food processing features, and recovered more than 200 kernels of charred, 8-row maize. Nevertheless, instead of large, permanent dwellings, we found an overlapping pattern of small, seasonal encampments. Floral and faunal remains from the site were diverse and included butternut, hickory nut, squirrel, moose, huckleberry, and raspberry. These remains indicated an early summer through fall occupation of the site, even though it was clear that people returned to the site for many years (Chilton et al. 2000).

The macrobotanical evidence from this site made it clear that the presence of maize on archaeological sites and the time period of occupation itself is not enough to allow us to interpret the importance of domesticated plants in pre-Contact economies. For example, all of the 200+ kernels of maize came from one pit feature and, in fact, could have been from one only cob (Chilton 1999). Furthermore, while there were numerous maize kernels in one of the 21 pit features, we had far more butternut shells and squirrel bone fragments than we had maize kernels. It was clear that we needed to look beyond a simple quantification of the macrobotanical remains in order to make interpretations of diet.

CERAMICS AS PROXIES FOR SUBSISTENCE CHOICES

As a result of what was, in retrospect, an obvious assumption—that one can not tell the importance of maize simply from the number of kernels found at a site—for my dissertation research, I undertook a ceramic attribute analysis of pottery from the Pine Hill site (Chilton 1996, 1998). As part of this research I examined attributes for 56 minimum vessel lots from the site. I then compared the results from the Pine Hill site to vessel lots from the Guida Farm site, in Westfield, Massachusetts, and the Klock site, an Iroquoian site in the Mohawk Valley. My goal was to test whether ceramic attributes can help shed light on the “intended uses” of pots (Chilton 1996). Those results strongly suggested that Iroquoian pots were intended to be—and, in fact, were functionally ideal—cooking pots for maize. In contrast, Algonquian pots from Pine Hill and Guida Farm were more diverse in nearly every attribute analyzed, but were otherwise not ideal cooking pots. I suggested that this reflected a lack of subsistence specialization for New England Algonquians, and that the diversity of pottery from the Connecticut River valley underscored mobility of settlement and fluidity of social boundaries. I subsequently proposed a model of “mobile farming” for Algonquians of the New England interior during the Late Woodland period (Chilton 1999), which I discuss below.

MOBILE FARMERS

The mobile farming model is based on the extant archaeological data for New England (Chilton 1999). It presupposes that in light of new data, the model should be reassessed. It is not based on a “natural state model” (Hart 1999b), in that it does not assume that maize farming necessitates sedentism, significant changes in diet, or social hierarchy. An underlying assumption of the model

is the perspective that “domestication can be measured more by its performance than by its consequences” (Terrell et al. 2003:325). Thus, looking for evidence for domestication in the plant remains alone is a false quest; instead, we need to look to the archaeological, social, and environmental landscape in its entirety, which necessitates an understanding of settlement patterns and paleoenvironment (Chilton 2002).

The mobile farming model is as follows: Native peoples of New England began to grow maize around A.D. 1000 or just before (this date is based primarily on AMS dates for maize since we lack stable isotope or other comparable data for the region). It was incorporated into an essentially hunting and gathering lifestyle, and while maize may have been ideologically and socially important to Native peoples during the Late Woodland period (ca. A.D. 1000–1600), it did not serve as a staple crop.

Evidence in support of the model includes the following:

- Late Woodland period settlements in New England are generally small, and dispersed, and seem to have been occupied for a season or two at a time, at most.
- There is no archaeological evidence for year round settlement during the Late Woodland period, except along the coast in some protected harbors. In those cases, the diet seems to have been centered on maritime resources.
- Structures on Late Woodland sites are small and ephemeral, and do not support a model of sedentism. There are a few cases of “longhouse” structures in New England, but they are either isolated structures or the dating is questionable. No evidence for pre-contact clusters of large, permanent structures has been reported in New England.
- Floral and faunal evidence on Late Woodland sites indicates a varied diet consisting of a wide variety of nuts, seeds, fruits, fish, shellfish, reptiles, and both large and small mammals. In terms of sheer quantity of macrobotanical remains, nuts often predominate.
- Analysis of archaeological ceramics indicates that they were manufactured in a wide variety of social and environmental contexts, lending further support to a certain degree of mobility throughout the year. The morphology of the pots also suggests that they are not specialized cooking pots, but were used for cooking and storing a wide variety of substances. In contrast, Iroquoian ceramics embody their use as specialized cooking pots for maize.
- Osteological evidence is sparse, but suggests that Native people had a varied diet and had generally

very good health throughout the Late Woodland period. There do not appear to have been significant changes in dental or dietary health beginning with the Late Woodland period or at any point in prehistory.

While there has been much debate on this model over the past decade (see Hart and Rieth 2002), no evidence has been found in the middle Connecticut River valley—or anywhere in New England—for large, sedentary farming villages.

STABLE ISOTOPE ANALYSES

When I went to Harvard University in 1996, right after completing my dissertation, I found myself in the company of archaeochemists, including my distinguished colleague Nikolaas van der Merwe. In many conversations, van der Merwe challenged me to ask more probing questions of the mobile farmers model. How long had New England Algonquians been growing maize? Had there been stable isotope analyses of human remains from the region? If stable isotope analyses on human remains were not possible, then what about non-human proxies? And why did there seem to be such a discrepancy between AMS dates on maize and standard radiocarbon dates on wood charcoal? For the next several years, my attention turned to issues of chronology and chemistry.

Bone chemistry would certainly provide an important independent test for the mobile farming model. Bone chemistry has been used in many cases to address questions about the relative proportion of various plant and animal foods in the diet, as well as mobility in general. Stable isotope analyses of bone collagen from sites in southern Ontario and New York indicate that maize was a dietary staple in these regions by ca. A.D. 1000 (Katzenberg et al. 1995; Schwarcz et al. 1985). Harrison and Katzenberg (2003) demonstrate that while maize was introduced into the diet by ca. A.D. 500, perhaps as a trade item, stable isotope analysis indicates that it did not become a staple until ca. A.D. 1000 in Ontario. Stable isotope analysis of human remains is the most direct and accurate way to determine the proportion of maize in the diet; one can assess the relative importance of maize, as well as other types of plants and animals, in the diet using the ratios of carbon and nitrogen in bone (van der Merwe 1982). Stable isotope analysis of human remains from the New England coast indicate that, while maize was present, it did not apparently constitute a large portion of the diet (Little and Schoeninger 1995). The destructive analysis of human remains in New England is not currently feasible due to NAGPRA, institutional collections policies, and out of respect for the wishes of many tribal groups. While the stable isotope analysis of dog remains

may provide a reasonable proxy for human diet (Chilton et al. 2001), a sufficient sample of late prehistoric dog remains from the New England interior has not yet been identified. In a collaborative project that I undertook a few years ago, there was apparently quite a bit of variability in the amount of maize consumed by dogs in the Northeast (Chilton et al. 2001), although this was a relatively small sample.

WHAT'S IN A DATE?

I have often been asked why it really matters *when* New England peoples adopted maize, given that I am far more interested in the *why* and *how*. The reason that the chronology of maize dates matters is that if maize was adopted and grown for 1,000 years—as opposed to say 200 years—before European Contact, then that would have important implications for how we interpret the seeming lack of intensive maize horticulture. Is mobile farming simply a reflection of a lack of expertise or experience in growing maize? Or was it a “cultural choice,” as I have suggested elsewhere (Chilton 1996, 1998)?

While we have learned quite a bit in the last few years about the chronology of the introduction of maize to northeastern peoples, the connection between the chronology of adoption and the importance of maize in Native economies is less than clear. In New England, we have direct dates on fewer than two-dozen maize samples, even though nearly 70 sites with maize have been reported. Elizabeth Little (2002) clearly demonstrated that most of the calibrated radiocarbon dates for maize cluster around ca. A.D. 1300–1500. My subsequent AMS dating of an additional eight sites confirmed this general cluster of dates, though there are a few dates that hover around cal. A.D. 1000 (Chilton 2005, 2006). While the pre-contact, direct maize dates cluster between cal. A.D. 1300–1500, the earliest dates for wood charcoal associated with maize are in the range of cal. A.D. 1000. Possible explanations for the lack of agreement between direct and associated dates include: (1) the wood charcoal found in association with cultigens may have been from “old wood” or an inner ring of a tree, which produces an older radiocarbon date (Schiffer 1982); or (2) post-depositional bioturbation or stratigraphic mixing that is not detectable by the excavators. Regardless of the interpretation of this phenomenon, direct dating of cultigens using AMS is critical for establishing an accurate chronology for the adoption and spread of maize horticulture in the region and, more broadly, in the Americas (Fritz 1990, 1994; Hart and Scarry 1999; Long et al. 1989).

Having more direct dates on maize kernels, however, will not ultimately answer the question of chronology. The earliest radiocarbon date for archaeological maize in

a region does not necessarily indicate when maize was first introduced (Hart 1999b). Maize may have been grown in New England long before we have evidence for it. The recovery of maize depends on the use of proper recovery techniques (i.e., flotation), the intensity of sampling, the intensity of maize use at the site, and whether or not it was burned before it entered the archaeological record (Hart 1999b, this volume; Hart and Means 2002). Thus, radiocarbon dates on maize give archaeologists a latest possible date for maize adoption and needs to be interpreted within the context of other subsistence and settlement data.

RESIDUE ANALYSIS

Aside from dating macrobotanical remains, there are other—perhaps more accurate—ways to get at chronology. Stable isotopic and phytolith analyses of ceramic residues also hold great potential for adding to the available body of evidence for maize horticulture. The presence of maize and squash phytoliths in pottery residues suggests the use of maize by Native peoples in New York State more than 2,000 years ago, far before the oldest macrobotanical evidence would indicate (Hart et al. 2007a; Thompson et al. 2004).

Stable isotopic analysis of pottery residues has been more problematic, and there is often little evidence of C4 plants (maize) in pottery residues (Morton and Schwartz 2004: 515). Hart et al. (2007b) suggest that there is a “non-linear relationship between the proportion of maize cooked in a pot and the resultant ^{13}C value of the residue.” They suggest that prior knowledge is needed of the types of foods that were cooked in the pot, underscoring the importance of phytolith analysis (Hart et al. 2007b). These techniques will give us an earliest mean date for maize use, but they will not ever be able to give us an understanding of either the exact proportion of maize in the diet or the chronology of settlement and cultural changes.

SETTLEMENT PATTERNS

At the risk of sounding old-fashioned, I want to emphasize the importance of settlement patterns for putting all of the archaeobotanical, archaeochemical, and radiocarbon data into context. Certainly, the most important bodies of evidence that we have for interpreting degrees of sedentism and overall economy are settlement patterns, that is, the patterning of structures and features within an archaeological site and the distribution of sites across the landscape in time and space. Settlement pattern data are not plentiful for New England, especially in comparison

to Iroquoian sites from neighboring New York and Ontario. This is in part due to historic disturbance, amateur digging, the scarcity of regional surveys, and geomorphological processes (Chilton 1999). There is little evidence for structures, much less villages, on Late Woodland (ca. AD 1000–1600) period sites in New England. For the New England coast, as Ceci (1979–80) and Luedtke (1988) suggest, there is no evidence for settled village life prior to European contact. There is evidence for year-round or nearly year-round habitation in some protected harbors on the coast beginning in the Late Archaic period (ca. 5000–1000 B.C.) (Bernstein et al. 1997; Bernstein 1993, 1999; Gwynne 1982), but this coastal sedentism is not a process that appears to be associated with the adoption of horticulture. Instead, because this process began in the Late Archaic period—long before the introduction of cultigens—it is likely that the year-round availability of both marine and terrestrial resources in these areas was the impetus for increasing sedentism.

For the New England interior, identifying postmolds on any archaeological site is rare; postmolds tend to be small, relatively shallow, and they are often disturbed by the typically deep and extensive plowzone. Rarely do these postmolds form a pattern that can be used to identify structure size or shape (see Chilton et al. 2000). For the most part, postmold patterns seem to indicate short-term, wigwam-type structures, and the overlapping nature of these structures and features, as well as a general lack of well-defined middens, indicates repeated seasonal use of site locations over time (Chilton et al. 2000). There is evidence for fairly large—although not necessarily year-round—Late Woodland sites in the lower Connecticut River valley, but these lack published settlement pattern data, making them difficult to evaluate (e.g., Lavin 1988). Occasionally there is evidence for large structures, or what have been called “longhouses” by some, in New England but these are rare occurrences, and they seem to represent multi-seasonal and potentially multi-component sites (e.g., the Goldkrest site in New York [Largy et al. 1999] and the Tracy Farm site in Maine [Cowie 2000]).

Of course one cannot judge the importance of maize simply from the size of houses. But intensive maize farming certainly requires a certain degree of sedentism, and it is this relationship between settlement and subsistence that apparently remains quite flexible in New England right up to the Contact period.

BROADER IMPACTS OF MAIZE RESEARCH IN THE NORTHEAST

“In the end we need to look broader for evidence of how the landscape itself was and is domesticated” (Terrell et al. 2003:349)

Understanding the timing of the adoption of maize by Native peoples is more than simply academic curiosity or professional debate: it has important implications for understanding the relationships among sedentism, farming, and social complexity in the region, and—more important—it has implications for understanding post-Contact Native history and contemporary Native issues in the region. A strategy of mobile farming with fluid social boundaries has important implications for how New England peoples have lived since European Contact (Bruchac and Chilton 2003; Chilton 2005). The more sedentary, tribal, Iroquoian peoples of upstate New York have fared better in the face of contact, at least if one measures success in terms of federal recognition, reservations, and historical continuity. The Iroquois were more formally recognized by Europeans during the initial Contact Period, in part because Europeans understood (relatively speaking) their use of land (intensive farming) and political organization (a form of representational government). In contrast, the English clearly did not understand the type of horticulture that was being practiced by New England peoples. Many of the New England planting fields would have seemed quite disorderly to Europeans, who at the time of Contact were more accustomed to intensive farming. In fact Europeans believe that New England's Native peoples were not "improving" the land (Locke 1980[1690]) and used this as an implicit justification for the taking of land. Europeans also did not understand or appreciate the more egalitarian social organization of New England peoples. This in turn affected the ways that Europeans treated them during the Contact Period and led to their near invisibility in historical writings after the end of the seventeenth century (Bruchac and Chilton 2003; Stein, this volume).

Likewise, the reason that so few groups in New England have received federal recognition is that the federal recognition process requires that native groups first establish their identity as a "tribe," with distinct social boundaries and a well-documented history, and that they then demonstrate some measure of cultural continuity. Federal recognition has important implications for tribal sovereignty and for land claims. The lack of federal recognition for Native groups in New England today also has serious implications for the repatriation of human remains and other objects under NAGPRA, the Native American Graves Protection and Repatriation Act (Public Law 101-601).

It is clear that we cannot make assumptions about what happened in New England after the adoption of maize on the basis of what happened in other times and places (e.g., the Iroquois). Instead, we need: (1) an accurate and detailed chronology for the adoption of maize and other tropical cultigens; (2) an accurate chronology for other major subsistence changes over the last 3,000 to 4,000

years, most importantly, the possibility of the cultivation of indigenous plants (e.g., chenopod, sunflower) (Asch Sidell, this volume); (3) an understanding of important environmental changes and subsistence choices that may have affected (or were the cause of) the adoption of maize during the Late Woodland period; and (4) a clear understanding of settlement and social changes (e.g., changes in level of sedentism, social boundaries, movement of peoples, etc.). Some of this will be gleaned from archaeochemistry and radiocarbon dating, and other equally important information will be gleaned from oral histories, historical research, and archaeological theory.

Based on the evidence we have at hand, pre-Contact New England provides us with an example of a society that is at once complex but not necessarily socially stratified, committed to horticulture but not necessarily living in year-round settlements. Thus, regional archaeologists have much to contribute to worldwide discussions on the causes, effects, and cultural choices involved in farming.

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CHAPTER 5

DICHOTOMIES AND THE “MAIZE DEBATE” IN LATE WOODLAND AND CONTACT PERIOD SOUTHERN NEW ENGLAND

by *Ninian R. Stein*

One of the largest controversies in New England archaeology is over the extent and intensity of Native American maize cultivation in inland areas during the Late Woodland Period ca. 1000–1600 A.D. (Bendremer 1999; Chilton 1999, 2002). This controversy can be seen outside of archaeology in contradictory academic and popular culture depictions of New England Native American subsistence, ranging from large scale maize farmers in some retellings of the Pilgrims’ story to pure hunter-gatherers in other depictions. Perhaps one of the reasons that subsistence in pre-Contact and Contact Period New England has been so controversial is because it challenges several English cultural dichotomies that persist as powerful remnants in our culture to this day. Specifically, Native American subsistence during the Contact Period ca. A.D. 1600–1700, challenged the English concepts of “nature” versus “culture” and the related dichotomy of “cultivation” versus “foraging.”

Despite early attempts to essentialize New England Native American subsistence into the nature/foraging categories, the ongoing debates indicate that for centuries this system has defied attempts to fit it smoothly into these constructs. Examining how pre-Contact subsistence breaks down these dichotomies can tell us a great deal about the dichotomies and the reasons for their construction and reconstruction over time. Perhaps understanding how Late Woodland Native subsistence challenges these systems can also help us to understand more of the reasons behind the controversy in archaeology today. Interwoven issues tied into the Western concepts of nature/culture and cultivation/foraging that will also be addressed in the course of this chapter are sedentary versus mobile lifestyles, labor, and concepts of social complexity. This chapter will primarily address societal underpinnings of the “maize debate” as well as the topics of settlement patterns, labor, and social complexity.

SUBSISTENCE PATTERNS IN LATE WOODLAND NEW ENGLAND AS LIMINAL

“Our approach, in essence, has been to accept the uncertainty—to let the obstacles leap out at us—and then, by unravelling their diverse institutional origins, to convert those obstacles into development signposts. In other words, the vast uncertainty itself is key.”
—Thompson, Warburton, and Hatley,
Uncertainty on a Himalayan Scale (1986:5)

As Thompson, Warburton and Hatley indicate, sometimes the fact of persistent uncertainty or conflict can itself be revealing (1986:5). In many cases, the study of conflict reveals political factors leading different groups to view the same data from divergent perspectives as could be argued has perhaps occurred at times in discussions of subsistence in Late Woodland New England. In this case, however, the conflict over pre-Contact maize in popular culture, history, and archaeology goes beyond political factors to point to societal and cultural level norms and dichotomies as well as inherent characteristics of subsistence at that time period. This chapter argues that pre-Contact subsistence for some Native American groups in some parts of New England was in a liminal state between the Western categories of foraging and cultivation. It is important to state from the beginning that this liminal state is not necessarily a transitional state as archaeologists studying similar liminal states sometimes imply.¹ Moreover, archaeologists discussing groups who have some of the characteristics of foragers and some of the characteristics of cultivators tend to consider these groups as in a specific transition—headed toward complete dependence on cultivation. In New England, however, there is little firm evidence in many areas to support

the notion of subsistence in transition until the Contact Period. One of the difficulties for many archaeologists in understanding New England maize cultivation is that there is no good evidence to support “pure” forms of either agriculture or foraging. Pre-Contact subsistence in New England is so controversial because it is liminal to Western categorizations, possessing some of the characteristics of both foraging and cultivation. This section looks at the conflict over the subsistence system and evidence for liminality and non-transition of subsistence patterns in Late Woodland New England.

As liminal is a term not usually applied to subsistence systems, it is important to begin by defining the concept as it relates to subsistence. The etymology of the word is that it is derived originally from the Latin word for threshold. The definition of liminal used here is “of or pertaining to the threshold,” which means intermediary between, or encompassing aspects of two or more categories.² Hence, dawn is liminal between night and day, a transitional example, whereas, a farm that has one field in wet rice and the second in swidden dry rice could be described as liminal between swidden and sawah, but not automatically in transition toward one or the other. It is important to indicate that New England subsistence can be considered liminal or between categories only by Western systems of dichotomization. There is no evidence to indicate that Algonquian-speaking Native peoples in New England considered foraging and agriculture to be dichotomous resource acquisition strategies.³

Liminal here is intended to be a non-transitional term. The threshold of a house never becomes either the outside or the inside of the house but remains between the two. Similarly, a liminal subsistence pattern does not have to be in the process of becoming either of the states it encompasses. It is also important to note that the phrase non-transitional is not being used in this context to imply ahistorical or without change. What is meant in this case by non-transitional is that there is no solid evidence that Late Woodland subsistence patterns were in middle of a transition or even headed toward a transition at the time of the earliest contacts with Europeans in the late 1500s and early 1600s. The view of the liminal state as non-transitional is not ahistorical, it simply counters the tendencies of most archaeologists and historians to assume that states between foraging and agriculture only exist if they are in active transition to agriculture. Despite the interpretations of archaeologists like Benison (1997), there is little solid evidence that the liminal subsistence patterns in New England were changing immediately prior to contact with Europeans.⁴

It is also worth looking at the definitions of cultivation and foraging. For the purposes of this argument, I will use the term “foraging” to refer to all non-cultivation-based systems of hunting and gathering or edible

resource procurement. The etymology of cultivation is from a sixteenth-century French noun of action, “*cultiver*,” which in turn is derived from Latin “*cultus*.” According to the Oxford English Dictionary, the definitions of cultivation are:

1. a. The tilling of land; tillage, husbandry. Also attrib., as cultivation field, system; cultivation bank, terrace, a bank or terrace formed either naturally or artificially on a cultivated hillside;
- b. Improvement (of land); increase of fertility. Obs. rare.
2. a. The bestowing of labour and care upon a plant, so as to develop and improve its qualities: the raising of (a crop) by tillage.
3. a. The devoting of special attention or study to the development of, or to progress in (a branch of knowledge, a person’s acquaintance, etc.).
4. The developing, fostering, or improving (of the mind, faculties, etc.) by education and training; the condition of being cultivated; culture, refinement.

—(From the 3rd Ed. of the OED)

It is interesting to note that the term “cultivation” refers to both the act of tending plants and to culture in the more anthropological sense, a linkage that will be discussed further in the section on the nature/culture dichotomy. The terms “hunting” and “gathering” as well as “foraging” also have definitions and problematizations to keep in mind. Ingold (1996:148) describes the traditional relationship between foraging and cultivation by saying “quite simply, foraging describes an interaction *within* nature, production describes an imposition *upon* nature of ideal form.” He then goes on to challenge the term “foragers,” writing, “Neither foraging nor production is an adequate description of what hunters and gatherers do,” and endorses Bird-David’s (1992) suggestion of the term “procurement” in its place. Keeping these definitions and problematizations of the terms in mind, the next step is to look at the archaeological evidence for these behaviors in New England.

Stepping outside of the debate to look at the actual archaeological evidence for subsistence in New England reveals that all of these systems utilized combinations of strategies, including in all cases some hunting and gathering as well as collection of marine or estuarine resources and some cultivation.⁵ Looking at the site reports for inland sites considered by some scholars to have a high reliance on maize cultivation reveals evidence for foraging strategies as well in the presence of numerous wild resources including deer, nuts, and berries among other

foodstuffs. Coastal areas had previously been considered to have the lowest utilization of cultivation and rely primarily on foraging for marine and terrestrial resources (Little and Schoeninger 1995). However, even in coastal systems there may have been small amounts of cultivation of maize, perhaps for ritual purposes, as evidenced by the fact that the only Native maize field excavated to date comes from Cape Cod, Massachusetts (Mrozowski 1994). A recent article by Little (2002:115) furthers the argument for maize cultivation in coastal areas.

Archaeologists have traditionally recognized states that are on this continuum between cultivating and foraging primarily in the contexts of transitioning to agriculture—liminal states assumed in this context to be transitional. Historically, anthropologists and archaeologists beginning with Morgan and Tyler tended to interpret cultural development on evolutionary or progressive schema that had cultures moving from lower stages of hunting and gathering to “more advanced” cultivation (Morgan 2000 [1877]:3). As a consequence of placing these as discrete stages, states in between were interpreted historically not on their own merits but as transitioning in one direction or another. Leach (1954) may have been one of the early scholars to describe a group not in transition between the categories while Smith (1998; 2001) has been an important archaeological voice on this topic. Although awareness of the topic has begun to change gradually within the discipline, Terrell et al. (2003:325) state that

left basically unchanged and unquestioned is the old idea that archaeologists should pin down when and where some of the earth’s ancient inhabitants finally stopped behaving like foragers long enough and successfully enough that the fortunate archaeologist who discovers their remains can label them posthumously as “the world’s first farmers.”

The idea that states on this continuum might not be in transition or that cultures might go the other way along the continuum is gaining ground in anthropology today.

The subsistence patterns in southern New England do not necessarily appear to have been in transition. This is not to say that the subsistence patterns were static, but that there is little good evidence that they were headed toward either “pure” agriculture or complete reliance on foraging. Archaeologists like Benison (1997) who argue for subsistence being in transition to a heavy reliance on agriculture have no solid evidence indicating that such a direction was taking place in many parts of New England. The quantitatively largest amount of archaeologically recovered evidence for large-scale maize cultivation comes from the Burnham-Shepard site in Connecticut, with a total of 1,500 kernels (Bendremer

1999:136). As Chilton (1999:160) argues, with approximately 240 kernels per ear of Northern Flint maize, this cache could easily have come from perhaps five ears of maize, hardly the quantity one would expect from large-scale cultivation. Reconsidering the locations of the kernels in the Burnham-Shepard collection and their spread across 16 different contexts (Bendremer 1993), I would be inclined to argue for a minimum of closer to 14 ears, higher but still within garden production quantities. As the second largest site, Morgan has at most 100 kernels represented, and the majority of the remaining 39 sites with maize that Chilton (1999:159) lists for the Late Woodland Period have mostly 1–5 kernels each. Chilton (1999:160) argues that it is unlikely that there is a correlation between presence of a cultigen in the archaeological record and its proportion in the diet. On a similar vein, I would argue that despite the acidic New England soils, one would expect that if maize were truly being grown on a large-scale basis that there would be larger quantities than a few kernels per site represented in the archaeological record (see Hart this volume). One would also expect a higher recovery rate for indirect evidence of large-scale maize cultivation, including larger quantities of identifiable tools related to cultivation (stone or shell hoes, etc.), a topic I am currently researching. To address this question, I am also turning to other lines of direct evidence including working with Youngsong Huang and Juzhi Hou of Brown University’s Geochemistry laboratory on a proof-of-concept for the idea of maize leaf wax residues in pond sediments as a possible additional source of data.

Paleoethnobotanists have at their disposal a set of potential tools for interpreting from data such as quantities of maize kernels at a site. Popper (1988:53ff) presents a number of tools used to extrapolate from quantities of remains including “absolute counts, ubiquity, ranking, and diversity” as well as ratios. As discussed above, one of the problems with the maize debate to date has been a tendency to disagree over the interpretation of maize kernels based on absolute counts from archaeological sites. Ubiquity is equally challenging to apply as one immediately encounters the large number of Late Woodland sites in southern New England without recovered maize remains (but see Asch Sidell this volume). Ranking as a method is, according to Popper (1988:66), most useful for larger quantities of recovered remains from comparable contexts that can then be divided into different assigned ranks. The samples at hand are mostly in amounts too small to be ranked successfully (0–5 kernels) and any attempt at ranking sites indicates the same as absolute counts that Burnham-Shepard and Morgan have more maize than other excavated Late Woodland Southern New England sites. Diversity, according to Popper (1988:69), similarly “requires high counts for each taxon,” making it potentially problematic given the low counts of

maize involved at most sites under consideration. Ratios stand out as a possibility for further consideration.

One of the challenges of interpretation for maize remains in Late Woodland southern New England is the difficulty of locating a ratio or other technique that will allow comparison across such a large range of sites with radically different preservation and even excavation techniques. The maize recovered from the Muskrat Hill site in the 1930s by Coffin (1940), for example, was recovered under radically different conditions from the modern excavated and floated Morgan site (Lavin 1988) in the Connecticut River valley. Not even charcoal counts, according to Miller (1988:75) a preferred method for standardizing ratios, are available for all Late Woodland sites, as collections from far too many sites excavated early in the twentieth century do not preserve all of the excavated charcoal.

In addition, Pearsall (1988:108) encourages us to consider “the source of the remains” in interpreting quantities of archaeobotanicals. In New England, maize as an introduced domesticate incapable of surviving winters on its own, has to be anthropogenic in origin. One remaining question about source is the difficult to answer question of whether maize kernels were intended for daily consumption or ritual purposes like the Green Corn Ceremony. The other question about source is clearly taphonomy and the numerous ways in which post-depositional processes effect the preservation and recovery of maize from Late Woodland southern New England (see Hart, this volume). Sites like Burnham Shepard and Muskrat Hill have such different taphonomic processes due to factors like proximity to the ocean, flooding from the Connecticut River or the presence or absence of shell middens that a general discussion is almost meaningless and a specific discussion would require a separate article.

Admittedly, following contact with Europeans some Native peoples did choose to adopt large-scale maize cultivation particularly in a few coastal trading sites. Bradley (1987), however, argues based on the role of trade goods that this may have been an attempt to enlarge an already existing set of indigenous trading networks to include European demands.⁶ Choices made by Native peoples after Contact should not be mistaken for directions that were inevitable before Contact. History is not moving toward a particular goal, and it is ill advised to assume that just because trade networks and maize cultivation expanded in coastal areas due to European ships that these expansions into agriculture were a path being taken before Contact. In fact, the example of the Mashpee Wampanoags, many of whom combined foraging, cultivating, and wage labor subsistence patterns into the early twentieth century (Campisi 1991), indicates that combined strategies may have continued to be preferable for survival.

A number of possible explanations exist for this recog-

nition of one subsistence strategy over another when both are present. Dove (1999) sees the tendency to overlook one subsistence strategy in favor of another when both are to some degree present as being in part due to privileging of one strategy over another by local groups for historical reasons. Similarly, anthropologists, archaeologists, and other observers may themselves be privileging one resource strategy over another in their own observations.⁷ I believe it is due to the fact that anthropologists and archaeologists, as products of Western civilization, are accustomed to looking for cultivating versus foraging societies, not for societies who comfortably utilize both strategies with few signs of change. There may again here be an influence from evolutionary theories of early anthropologists like Lewis Henry Morgan, who categorized societies into what he believed to be a progressive scale, the first criteria for which was the adoption of agriculture (Morgan 2000 [1877]:3). Marxist archaeologist V. Gordon Childe, pioneer in the study of domestication, also appears to have considered farming more evolved than foraging and helped solidify these as distinct stages in early archaeological literature (Childe 1951; Pluciennik 2001:748). Brody (1981:52) writes “the academic voice added to a prejudice that made it impossible for Europeans to see hunting societies as real economic systems.” Finally, liminal states where strategies of both foraging and cultivating are used can be hard to see if observers are expecting a dichotomy.

CULTIVATION/FORAGING

The idea of a dichotomy between foraging and cultivating societies in Western civilizations can be traced back at least as far as the first written text “the Epic of Gilgamesh” ca. 2700 B.C., according to Kovacs (1989:xxv), and probably predates that work as well. In the beginning of the epic, Gilgamesh, ruler of a settled agricultural society, is clearly contrasted with the “wild” forager Enkidu (Kovacs 1989). Dating this dichotomy before “the Epic of Gilgamesh” is difficult; however, Short (1991:5) speculates that it may date to the time period in which a distinction between settled agriculture peoples and other groups may have become important. In Western Europe, this would have been during the expansion of the Bandkeramik, a farming-domestic animals-pottery complex that swept the continent replacing foragers in most locations ca. 7000–5300 B.C. (Fagan 1996:215).

Beyond the bias toward seeing only foragers or cultivators, there are also other reasons why liminal states can also be problematic to recognize. By setting the difference between foragers and cultivators as a strong dichotomy, groups who fail to live up to the foraging ideal in this

view become less desirable, perhaps even invalidated in some eyes. This potentially creates a bias against recognizing groups as utilizing multiple strategies as it could lead to the group being devalued or considered less than “pure,” with potential political consequences for the anthropologist as well as the group being studied. Posey (1998:114) describes this danger, stating that:

The undermining of such finds would be enthusiastically received by some governments, political and economic decision-makers, banks, and development agencies that would like nothing more than to prove that culture is divorced from the environment, just as ecological conservation would be divorced from human rights, or development from local communities. Developers could then continue to move and remove indigenous peoples from their lands with impunity and with the implicit blessings of science—and historical ecology.

Liminal states are thus tricky to recognize both because there is a bias against seeing them and because there are potential political consequences from that recognition for viewer and viewed.

As long as it is done carefully, however, there are good reasons to challenge the cultivation/foraging dichotomy, particularly because of the almost overwhelming evidence that these categories are not mutually exclusive strategies. Brosius (1991:131) addresses this issue:

Bailey and Headland speak of agriculture and foraging as if these two modes of subsistence were strictly dichotomous. In fact the distinction is not so clear, either conceptually or with respect to the biological and demographic processes of the resources being exploited.

As is the case in New England, Brosius has recognized that subsistence patterns can exist which utilize strategies from both categories, and that, moreover, some of the strategies on this spectrum may not firmly belong to either category. Terrell et al. (2003:329) write that “instead of seeing domestication and the development of agriculture as an event, a transition or a turning point—or perhaps not even a continuum,” archaeologists could consider turning to the larger picture through the consideration of human modifications to landscapes.⁸ Pluciennik (2001, 2002:98) encourages anthropologists to think “across such deep seated categories.” Brody (2000:288) stands out as unquestionably the most comfortable with liminal states, writing:

In reality, there is a possible spectrum of economic systems— with hunters at one end, farmers at the other and many kinds of mixtures in between— rather than two exclusive categories, some pair of opposites that between them include all possible human societies. In this respect, the hunter-gatherer:farmer divide is itself a form of myth.

Brody’s concept of “mixtures” blends well with the southern New England evidence. The current best archaeological evidence for subsistence in Late Woodland Period New England indicates that despite local differences the majority of the Native groups utilized foraging, cultivation, and intermediary strategies. That these liminal subsistence patterns occur throughout the globe indicates that scholars need to find a way to move beyond the cultivation/foraging dichotomy to discuss these intermediary strategies without stigmatization or negative consequences in the discipline and in the larger political world.

The cultivation/foraging dichotomy has been applied to Late Woodland New England repeatedly, generally with confusing results as a consequence of the liminality of subsistence during that time period. The colonial literature is full of contradictory depictions of Native peoples as foragers or farmers. Cushman, in his 1621 essay “Reasons and Considerations touching the lawfulness of removing out of England into the parts of America,” describes the Native peoples as foragers who “do but run over the grass, as do also the foxes and wild beasts” (1974:91). Smith (1898 [1616]:17), in contrast, describes the Massachusetts coast as showing “all along large corn-fields and troops of well proportioned people.” Potential reasons for the contradictory depictions include gender biases, poly-crop versus mono-crop differences, the desire to attract new settlers by presenting the land as either uninhabited or abundant, and land claims issues. To this list, I would now add the difficulties of seeing a liminal state if the observers are looking for a “pure” dichotomy.

A second complicating element is gender. In Contact Period New England, based on historical sources including Wood (1977 [1635]), women were primarily responsible for cultivation and gathering, men primarily for hunting, and both genders for some degree of fishing as well as assistance in all many “opposite-gendered” tasks (Bendremer 1999:144; Bragdon 1999:576). Although this division of labor was present throughout the eastern seaboard of the New World, Seed (2001:45) notes that English colonial texts, unlike Spanish and Portuguese texts from the same period, are full of references to the gendered division of labor, a fact that Seed attributes to the land claims issue. As cultivation of land conveyed ownership in the English legal system, Native women,

not men, were theoretically the owners of much of New England. This situation was unacceptable to colonial English men, who “did not wish to characterize their imperial ventures as a struggle against women overseas” both for popularity reasons and because they feared that English women would be inspired to take up farming in order to own land (Seed 2001:46). That Native women’s ownership was viewed as a threat by English men is clear in the writings of William Wood (1977 [1634]) among others, as many colonial male authors go to great lengths to describe the life of Native women as onerous, creating what Seed (2001:46) calls the “myth of the ‘squaw drudge’.” Thus, in order to maintain male power and land ownership in English society at home and in the New World, as well as to avoid Native land claims, there may have been a tendency among male colonial observers to avoid recognizing Native women’s cultivation, even when present alongside hunting-and-gathering subsistence strategies.

A third complicating element is land ownership—in seventeenth-century English society, foragers and cultivators theoretically had different legal ties to land. Thus in colonial contexts like New England, there can be political motivations to consider an indigenous group to be foragers rather than cultivators. The English during the colonial period were no exception to this, and there were a range of motives that may have led different Englishmen to describe New England Native peoples as hunters, hunter-gatherers, or maize cultivators. A major English motivation came from the fact that according to the English legal system as codified by John Locke in the late 1600s, cultivation or “improvement” of land conveyed ownership of the land improved (except in the case of tenant farmers). However, Seed (2001:47) writes that under the English legal system hunters did not necessarily own the land “upon which they pursued game.” A decision to describe Native peoples as foragers versus farmers could thus imply they had few ties to the land. In contrast, the founder of Rhode Island, Roger Williams, used instead a characterization of Native peoples as maize agriculturalists to argue for Native land ownership (Rubertone 2001; Seed 2001:53). English law did not allow for liminal states between foraging and cultivation, those engaged in both had legal rights only to the land modified by their “improvements.” Similarly, although some English colonial writers described a range of cultivation and foraging strategies as comprising Native subsistence, few of them recognized this as a liminal state, privileging instead one or the other aspect of the dichotomy depending upon worldview and political agenda. The characterization of Native peoples in relation to the cultivation/foraging dichotomy did not end with land claims, and had related implications for perceptions of Native labor, or perhaps a lesser dichotomy of industriousness versus laziness.

A fourth complication is colonial attitudes toward work, with cultivation seen as industrious and foraging seen as lazy. Throughout history, numerous agricultural societies around the world have characterized neighboring foraging communities as lazy in contrast to their own industriousness.⁹ The English colonists placed a very high value on industriousness; indeed the Puritan religion considered idleness a sin (Kupperman 1980; Pluciennik 2001: 742). Cushman(1974: [1621]:92) literally presents Native American lack of industriousness as a justification for English colonization of America, stating, “they are not industrious, neither have art, science, skill or faculty to use either the land or the commodities of it.” Locke (1986 [1690]) makes a similar argument about Native American lack of industriousness. As indicated in the colonial English legal code where the labor of cultivation is “rewarded” with ownership, cultivation was clearly associated with the good of industriousness. Hunting and gathering, however, are more complex matters, with different, and in some cases ambivalent, values placed on different types of subsistence activities.

Although cultivation was clearly labor to the English in the 1600s, they were less clear about hunting as a form of labor. Due to Norman influences, Seed (2001:48) writes that the English considered hunting a privilege or recreation for nobility and landed gentry rather than a form of work. Rather than recognize the subsistence contributions of hunting to Native New England diet, Englishmen viewed hunters as lazy or idle. These views continued throughout the early 1700s and into the 1800s. Benjamin Franklin, for example, blamed the failure of colonial efforts to “civilize” Native peoples on “the Proneness of Human Nature to a Life of Ease” provided by “the Spontaneous Productions of Nature, with the additions of very little Labour, if Hunting and Fishing may indeed be called Labour when Game is so plenty” (cited in Perdue 1995:101). It is important to note that not all Native peoples were equally considered lazy, this stereotype was placed squarely on male shoulders with a countering image of Native American women as industrious but overburdened workers.

Native women in New England unquestionably performed labor in cultivation, as evidenced by the wear patterns on the skeletons studied by Rubertone (2001:153) from RI-1000. Similarly, well-worn hoes, mortars, and pestles are found buried with adult women at RI-1000 (Rubertone 2001:156) and at the burial ground on Conanicut Island in Narragansett Bay (Simmons 1970:45), among countless other places, indicating women’s roles and testifying to their labor in cultivation. Only by overlooking the labor of Native women were Englishmen able to characterize New England Native peoples as lazy. Labor, as one of the forces that according to the colonial English separated cultivators from foragers, is an impor-

tant issue nested within the dichotomy between farmers and foragers. English decisions to recognize or overlook the labor of Native women and to characterize Native peoples as hunters or foragers based exclusively on the subsistence strategies of Native men effected the balance of where New England Native peoples were considered to fall within the cultivation/foraging dichotomy.

A fifth issue in distinguishing foraging and cultivation is that of “progress” or social complexity, where historically foraging was considered by anthropologists among others to be more “primitive” in comparison to more “civilized.” This attitude toward agriculture as foundational to social complexity can also be seen in the writings of early anthropologists like Morgan and Tyler who made agriculture the primary basis for advancement beyond the “lower” levels of humanity in their organizational schema (see Morgan 2000 [1877] for example). Pluciennik (2001, 2002) traces the history of these ideas even further back to eighteenth-century philosophers including Adam Smith. The association is also revealed in the ongoing debate in archaeology over whether a state level society can exist without agriculture (Fagan 1996). Many archaeologists consider Michael Moseley to have solved this question in 1975 by discovering the circa 3000 B.C. urban center of El Paraiso in coastal Peru that was dependent upon fishing rather than cultivation for subsistence (Fagan 1996). Despite Moseley’s discoveries however, the association between state-hood (considered the apex of social complexity by earlier generations of archaeologists) and cultivation remains.

A sixth complication is the use of characterizations of Native peoples in New England and elsewhere as foragers or cultivators in relation to modern-day legal challenges to land ownership. In recent decades there have been active land challenges ongoing in southern New England as well as a history of courts using anthropological debates to redirect and deny New England Native groups’ land claims (Campisi 1991). From the perspective of accessing land claims through recognition of Native women’s labor in cultivation during prehistory and the Contact Period, the concept of a subsistence utilizing strategies from both cultivation and foraging could be potentially undermining or, more constructively, open the door to the idea that subsistence activities other than farming could perhaps over time convey ownership as well. Several Native groups in New England are currently pursuing Federal Recognition, including the Mashpee Wampanoags, who have received recognition after decades of struggle. The recognition process includes requests for archaeological or historical information documenting long-term ties to the landscape (United States Government 25 *CFR Part 83*). Given the difficulties of the Federal Recognition process and the fact that the Mashpee and Nipmuc among other groups, have been on

the waiting list for over a decade, it is not at all clear whether archaeological evidence indicating subsistence liminality could affect the process. The potential consequences for present-day Native peoples in New England of prehistoric subsistence utilizing strategies from both cultivation and foraging is difficult to determine, as on one hand it may represent a more accurate understanding of history, but one that could work for or against groups in courts of law or in the Federal Recognition process.

NATURE/CULTURE

Older even than the dichotomy between cultivation and foraging is the Western dichotomy between nature and culture. The conflict between nature and culture appears in the Epic of Gilgamesh in the form of the transformation of Enkidu from wild to civilized after which “the gazelles saw Enkidu and darted off,” indicating the distance between the two states (Kovacs 1989:8). Short (1991:5) believes that the dichotomy dates to the era of the agricultural revolution ca. 10,000 years ago, and states that “the term wilderness emerges then because it is only with settled agriculture that a distinction is made between cultivated and uncultivated land, savage and settled, domestic and wild animals.” The liminality of New England Late Woodland subsistence patterns has also interacted with the nature/culture dichotomy in a multitude of ways both in academia and in popular culture throughout time. This section begins with a brief look at the history of the nature/culture dichotomy before moving into a discussion of how this dichotomy has been related, however inappropriately, to New England Late Woodland subsistence, by colonial writers, media through the last few centuries, and finally by modern archaeologists and anthropologists.

History of The Nature/Culture Dichotomy

The nature/culture dichotomy can be traced back to ancient Greek and Roman origins, as well as to divides within the sciences of the Middle Ages and later. Lloyd (1992) traces the concept of nature back to Greek antiquity, where the dichotomy does not seem as pronounced. The Romans seem to have made the dichotomy more pronounced by using the word “natura” to differentiate “the natural world—‘the world of born’—from the manufactured world—‘the world of made’” (Ashworth 1999:xi). Murray (1992), looking at humanity and nature during the Middle Ages sees the science of the times as fraught with divisions and dichotomies, some of which may have given rise to the divide between nature and culture. With this history behind it, it appears the nature/culture dichotomy was well established by the time of the earliest English explorations of New England in the late 1500s.

The nature/culture dichotomy is of course cultural in origin and something that youngsters in a culture have to be taught. Ryden (2001:6) notes that as children "we have to learn that nature is strictly separated from culture, both conceptually and spatially; its exceptional quality has to be explained to us until we believe it." This would have been as true for those hearing the original "Epic of Gilgamesh" as for us today.¹⁰

One important question that could be a separate chapter is the issue of how the cultivation/foraging dichotomy fits within the larger nature/culture dichotomy. To begin with it is important to note that to Englishmen in the 1600s and 1700s, subsistence defined where a group fit within the nature/culture dichotomy. Benjamin Rush, writing in the 1700s, spelled out the beliefs of colonial Englishmen clearly by stating that "the savage lives by fishing and hunting . . . and the civilized man by agriculture" (cited in Perdue 1995:91).¹¹ For colonial Englishmen, subsistence was what defined whether a group was part of "culture" and "civilized" or part of "nature" and "savage."

These associations lead to the issue of definitions and what composes the category of culture versus nature. Although many factors include culture itself, settlement patterns and labor patterns contribute to the definition of culture, and the etymology of the word indicates that its root is the same as the root for cultivation. The root comes from the Latin verb "*cultra*" meaning tending or raising of plants (Oxford English Dictionary, 3rd ed.). Looking up "culture" in the Oxford English Dictionary produced surprising results: the familiar anthropological definition is the fifth definition listed, whereas the second and third (after the rare worship or reverence) are

2. a. The action or practice of cultivating the soil; tillage, husbandry; = Cultivation
- b. Cultivated condition. Obs. c. concr. A piece of tilled land; a cultivated field. Obs.
3. a. The cultivating or rearing of a plant or crop; = CULTIVATION.

Essentially, the original definition of culture is cultivation, which makes the dichotomy of nature versus culture parallel to that of foraging versus cultivation. Although the definition of culture as stages of civilization was in use by the 1600s (Fagan 1996:160), throughout the colonial period the association between the "civilization" definition of culture and cultivation would have remained strong. Scholars today make the separation between the modern anthropological definition of culture and the concept of cultivation; however, it could be argued that this earlier association persists in subtle ways in the English language and U.S. society. Culture and cultivation are thus intimately associated in the English language and worldview, leading to the oppositional categories, nature and

foraging being associated at times as well.

As Williams (1980:67) points out in his essay "Ideas of Nature," nature is difficult to define because it can encompass a range of different definitions and historical nuances for a single people. Several meanings which Williams (1980:72) encounters in Shakespeare's *King Lear* are relevant for this discussion, "nature as the primitive condition before human society," nature as landscape or uninhabited areas, and nature as a "personified goddess." The concept of nature as the condition predating human society is particularly revealing when the nature/culture dichotomy is compared to the foraging/cultivating dichotomy, because if a society considers culture to be defined by cultivation then foraging becomes a part of "nature." In another interpretation of these dichotomies, Ingold (1996:148) writes that in "the producer is seen to intervene in natural processes, from a position at least partially outside them; the forager is supposed never to have extricated him or herself from nature in the first place." This Western cultural connection between foraging peoples and nature is one that has followed New England Native peoples since the Contact Period.

Nature/Culture Dichotomy in Late Woodland New England

Beginning with the earliest colonial writings, in New England there is a long history of how Late Woodland and Early Contact Period subsistence patterns were placed relative to the nature/culture dichotomy. For the majority of colonial authors, particularly those who spent little time in New England or had little interactions with southern New England Native peoples, Native subsistence and people were associated with nature or "the wilderness" that English settlers considered the landscape to be. This association can be seen clearly in the writings of Robert Johnson, an English propagandist who never went to the New World but who stated in 1609, that "it is inhabited with wild and savage people, that live and lie up and downe in troupes like heardes of Deare in a Forrest: they have not law but nature" (cited in Kupperman 1980:47). Coates (1998:104) writes for the English settlers, "wilderness was reviled as the diabolical abode of the savage Indian." Much of this association to "wilderness" as a category within "nature" probably comes from the King James Bible where it is clearly contrasted with the labor and works of men in the story of the expulsion from the Garden of Eden (Cronon 1996:71). Even Roger Williams (1973 [1643]:172) utilizes this image writing:

The Wildnesse remembers this,
The Wild and howling land
Answers the toyling labour of
The Wildest Indians hand.

In this case, however, Williams is making use the image of the wilderness in a way that subtly subverts the dominant colonial wilderness discourse by presenting Native peoples as farmers/culture, subduing the “wild” land in a manner parallel to English farmers and so perhaps conveying the same property rights. It is interesting that in order to subvert the idea of Native New England peoples as part of the “wilderness” or nature, Williams has to utilize the opposite part of the dichotomy and convey the image of the Native Americans as farming. Williams’ poem could be interpreted as striving for a middle ground between the dichotomies in the phrase “the toyling labours of the wildest Indian’s hand,” as he is evoking the ultimate act of culture, labor in cultivation, but also describing the cultivator as “wildest.” As a friend of the Narragansetts, Williams had spent a lot more time with Native peoples than had authors like Cushman or Johnson. It is very telling that colonial period authors who had not spent very much time with New England Native peoples tended to characterize them as part of “nature” or “the wilderness,” whereas authors like Roger Williams are more likely to problematize the expected association. Despite the ambiguities and breaking down of categorizations in the writings of authors like Williams, the image of New England Native peoples as associated with “nature” is the one that would be perpetuated during the following two centuries.

The nature/culture dichotomy was reintroduced to anthropology through the writings of Claude Levi-Strauss in the mid-twentieth century (1964, 1973). Archaeologists who engaged with these ideas include Neumann and Lilburn (1995:126), who characterize the dichotomy as “a cultural myth that separates people from nature, a Rousseau-ian image in which proto-historic populations had no impact on the world around them” (Neumann and Lilburn 1995:136). They also take this argument one step further and critique wilderness areas and wildlife management programs that fail to take into account prehistoric human impacts in those areas stating “one cannot develop environmental policies by using cultural myths, regardless of the appeal of the myths” (Neumann and Lilburn 1995:136). Another archaeologist to address this myth is Rubertone (2000:108), who writes “the English concept of ‘wilderness’ failed to capture the complexities of the Narragansett homelands.” Archaeologists, like anthropologists, have begun to critique the language of the nature/culture dichotomy and its accompanying wilderness debate in discussions of the New England landscape.

Not only did Late Woodland southern New England Native peoples transcend the Western nature/culture dichotomy through their subsistence patterns, in all probability they would have rejected it as a concept as well. Ingold (1996:117) writes that hunter-gatherers (as well,

perhaps, as mobile-farmers) “systematically reject the ontological dualism of that tradition of thought and science which—as a kind of shorthand—we call ‘Western,’ and of which the dichotomy between nature and culture is the prototypical instance.” Also in support of the rejection of dichotomies, Brody (2000:288) states: “The use of binary pairs to create an analytical grid is at odds with the way in which indigenous cultures, starting with hunter-gatherers, achieve so much by avoiding dichotomies.” Although it is difficult to extract the relevant Native New England categories from colonial works, it is very clear that they had not constructed dichotomies that mapped directly onto the Western ones. Williams (1973 [1643]: 167ff) records words for “earth or land,” “fields worn out,” and a host of terms for cultivating maize but no words for nature, wilderness, or fields in cultivation. This apparent absence of the Western dichotomy can also be seen in part in early land deeds, as Native land deeds grant usufruct rights; even in English written deeds, Native passages on usufruct rights are visible whereas the English viewed land transfers as conveying the entire value of the land (Cronon 1983; Little 1981). Southern New England Native peoples doubtless possessed emic systems of categorizing lands, however, these are harder to find in colonial era documents.

Not only in their language and worldviews, Native peoples in New England also broke down the nature/culture dichotomy through their actions. Native peoples in New England were mobile during the Contact Period and after as evidenced by centuries of English settlers’ comments about transience of Native peoples (Calloway 1997; O’Brien 1997; Thoreau 1860). This mobility, which so frustrated the English because they viewed it as “uncivilized,” challenged the order of the English view of landscapes as divided between gardens versus wilderness, and instead led to a unified landscape filled with a range of usufruct rights.

CONCLUSION

Subsistence patterns in Late Woodland New England are liminal in regard to Western categories, possessing the characteristics of both cultivation and foraging, and so challenge the Western dichotomies of cultivation versus foraging and nature versus culture. The debate in archaeology over these subsistence patterns is in part due to the political implications of recognizing states that are intermediary between these dichotomies yet not in transition toward cultivation. Because New England Late Woodland subsistence appears to have incorporated strategies from both cultivation and foraging, it is necessary to step outside the dichotomous Western view of cultivation and foraging as mutually exclusive states. This is

difficult in part because the cultivation/foraging dichotomy is located within the nature/culture dichotomy, and combining the two subsistence systems has consequences for our understanding of how southern New England Native peoples interact with “nature” or “wilderness” that in turn breaks down the nature/culture dichotomy. Although questioning Western ideas of “nature” or “wilderness” can be threatening by appearing to remove an important contrast for our own society, perhaps we will be able to replace the contrast with a more achievable challenge of having only light or sustainable impacts on our environment. In this case, examining an archaeological debate about subsistence in Late Woodland New England has revealed powerful Western dichotomies impacting colonial authors as well as modern scholars. Only by stepping beyond the Western foraging/cultivation and nature/culture dichotomies will archaeologists be able to see the larger picture of subsistence and indeed lifeways of Native peoples in Late Woodland and Early Contact Period southern New England.

END NOTES

¹ See, for example, the works of Price and Gebaur (1995).

² The definition in quotes is from the 3rd edition of the *Oxford English Dictionary*. van Genep (1909) and Turner (1957, 1969) were two of the scholars to introduce the use of the term “liminal” in anthropology.

³ The neighboring Iroquoian agriculturalist groups may have made distinctions between agriculturalists and foragers; however, that is outside the scope of my current research.

⁴ It is important to state that archaeological evidence could be revealed in the next few decades that could indicate that a transition was taking place; however, given the current absence of any such data, this statement stands for the time being.

⁵ Chilton’s concept of “Mobile-Farmers” (1999) makes this point for inland areas, however it is worth pointing out that this mixture of foraging and cultivation appears to extend throughout all of the subsistence systems in New England.

⁶ There is good evidence for active pre-Contact trade networks trading among other things Native copper, maize, and certain types of locally unavailable stones; networks which were expanded to include European copper, etc. (Bragdon 1996:92).

⁷ This is especially easy to do in archaeology where the choice of excavation methods, screening versus flotation, can significantly impact the quality and types of subsistence information recovered, and can bias the record toward subsistence strategies with larger remains.

⁸ Other recent authors have also recognized the use of multiple subsistence strategies notably Posey (1998:111) for the Brazilian Kayapo plant introductions into forest islands, Linares (1976) for the concept of “garden hunting,” and Dentan et al. (1997:43) for the swidden and foraging systems of the West Semai in Malaysia among others. In a parallel continuation of two strategies, Dove (1999) discusses the preservation and continued propagation of ancient cultigens outside the primary subsistence regime; for example, tubers in a rice farming system. Ames and Marshall (1981) and Ames (2006) also address the adoption of multiple subsistence strategies on the Southern Columbia Plateau,

while Lepofsky and Peacock among other articles in Prentiss and Kuijt (2004) more cautiously propose the same for the Northern Plateau. A few of the theorists working on plant and animal domestication even propose the existence of transitional states incorporating strategies from both foraging and cultivation (Flannery 1972; Braidwood and Howe 1962:136), which they view as purely temporary in nature as opposed to the more lasting non-transitional liminal states discussed by Posey (1998) and others. Even Bailey et al. (1989) for all their portraying the absence of “pure” foragers as a negative, nevertheless describe numerous examples of liminal states incorporating foraging and domestic plants or animals.

⁹ See for example Wilmsen’s *Land Filled With Flies* (1989), Brody’s (1981) *Maps and Dreams* and *The Other Side of Eden* (2002).

¹⁰ Although it is tempting to see the dichotomy as purely English in cultural origin, it is important to note that the modern citizens of the United Kingdom seem to no longer hold to the dichotomy as strictly as many US citizens. Frake (1996) describes this in his work when he notes that rather than being upset by the discovery that the Norfolk Broads of East Anglia were a created place, the “the study became well known and widely accepted, so far as I can discern, without much comment almost immediately.” Recognition of the Broads as having a human history seems to have led to more special protection rather than less, part of the larger picture of acceptance of the human history and impacts on wilderness areas in the United Kingdom. Although the nature/culture dichotomy may have come over with the early colonists from 1600s England, it can no longer be considered to have an active ongoing counter-part as applied to the British Isles. The persistence of the nature/culture dichotomy in the United Kingdom in the form of a concept applied to areas outside of Europe is another issue entirely and one that is beyond the scope of this research.

¹¹ Rush actually includes an intermediary category, the barbarian, who he asserts “lives by pasturage”; however, based on his discussion it appears that this category fits within the nature side of the nature/culture dichotomy rather than existing between the two aspects of the dichotomy.

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CHAPTER 6

MAIZE AGRICULTURE IN COASTAL RHODE ISLAND: IMAGINATIVE, ILLUSIVE, OR INTENSIVE?

by *Tonya Largy and E. Pierre Morenon*

Was agriculture central to Narragansett, Niantic, Pequot, and Wampanoag peoples before the development of European communities in the early 1600s? Did indigenous peoples only adopt intense agricultural practices after European settlements developed in Providence and Rhode Island Plantations? These questions could surprise many tribal members or educators who recite how the Pilgrims of Plymouth Plantation were saved from starvation by local indigenous farmers in 1620. Moreover, scholars (Salwen 1978; Simmons 1978) have long drawn from the descriptions of fields and planting cycles described around Narragansett Bay by Verrazzano (Wroth 1973) in 1524 and later by Williams in 1643 (Williams 1970).

Yet, until recently archaeologists had not reported unambiguous maize kernels or beans from any of the hundreds of pre-European archaeological sites studied through hundreds of completed cultural resources management studies in Rhode Island. In contrast, archaeologists working at “Contact Period” Fort Ninigret (Salwen and Mayer 1978) had recovered abundant maize kernels (Figure 6-1) during the 1970s that were associated with a probable seventeenth century Dutch trading post in southern Rhode Island. Thus, for over thirty years archaeologists (Bernstein 1993; Ceci 1978) rightly questioned the centrality and timing of agriculture in New England coastal settings like Rhode Island.

This chapter is based on a systematic inspection of all of the known maize extracted from archaeological contexts around Narragansett Bay. Some of this evidence and some of our arguments were presented in a paper delivered at the Society for American Archaeology 71st annual meeting (Largy and Morenon 2006). Here we also discuss ongoing research completed between May 2006 and January 2008. Our effort is intended to highlight unreported and recent evidence, as seen in Figure 6-2, and to explore the implications of this evidence. Part of this discussion is to provide context for this new maize evidence



Figure 6-1. Maize recovered in 1974 from Fort Ninigret (RI15) in Charlestown, Rhode Island.

from pre-European sites. Narragansett Bay and coastal Rhode Island was indeed intensively farmed after ca. A.D. 1100. We also discuss here the first AMS dates of maize kernels from Fort Ninigret, derived from the earlier and most recent (Taylor 2006) archaeological investigations there. Although our work emphasizes documenting botanical remains, other lines of evidence—such as the content analyses of historic writings or the ^{14}C record from features and settlement locations—reinforce our reasoning.

CRITICAL QUESTIONS

Two critical questions were raised at a preview (Morenon and Largy 2006) of our findings to an audience of chemists, molecular biologists, and botanists at a Sigma

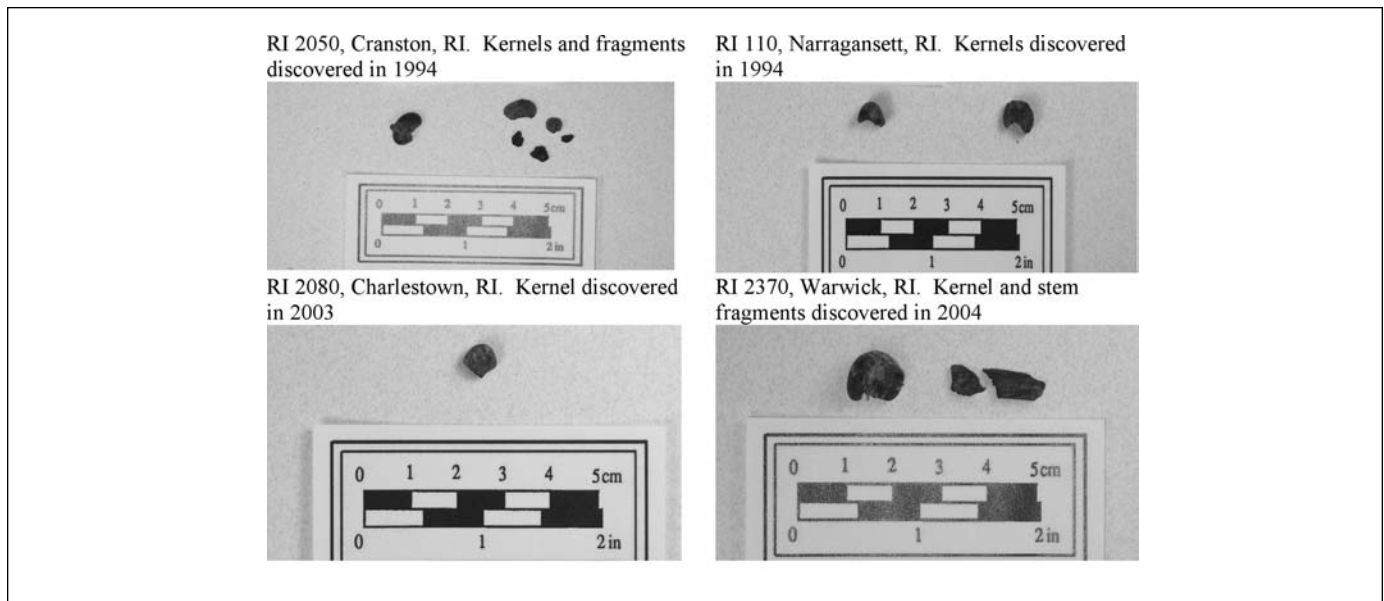


Figure 6-2. Maize from four archaeological sites in Rhode Island discovered after 1990.

Xi luncheon at Rhode Island College that listened to our arguments. The first question concerned the evidence: How confident are archaeologists and archaeobotanists with conclusions based on a sample of one or very few sites, each with a few specimens? We do have a very small sample of maize from coastal Rhode Island. Until the 1990s the only archaeological site with maize was Fort Ninigret (RI 15) (Mayer n.d). Today there are five other unambiguous pre-European archaeological sites with maize around Narragansett Bay in a narrow band along the coastal edge as illustrated in Figure 6-3. One additional site (RI 2370) contains maize (Figure 6-2), but this specimen is not clearly of pre-European age. However, archaeologists and archaeobotanists need not apologize for our scanty information. We are hardly alone when it comes to relying on just a little evidence, because, as we will see, the meaning of an historic observation may depend on one document, a single word can be of great significance.

The second question raised by these scientists at the Sigma Xi presentation was about the logic used by archaeologists to dispute historical and cultural views about the centrality of maize agriculture to Narragansett peoples in the first place. The argument goes like this: The long-held dogma about the importance of maize to Native American communities in coastal areas is not supported by the archaeological record from excavated sites. Therefore, maize based agriculture must have intensified after or was not intensive before the arrival of Europeans. The question raised by the Sigma Xi scientists was pointed: How does one support or refute arguments about

intensification with *no* physical evidence? Making an argument from no evidence was weakly persuasive to this audience.

From their point of view, no evidence means many things: inappropriate procedures, insufficient work, poor preservation, and so on. While the new evidence, which we describe here, is a small sample, it enables us to reexamine questions that were not possible a few months ago and to provide impetus to ongoing research efforts in the region. Archaeologists and archaeobotanists understand that tens of thousands of hours of tedious work underlie these few specimens. Even mathematicians appreciate the distinction between zero and some evidence. Does the historical evidence support the claim for intensive pre-European agriculture around Narragansett Bay?

How do archaeologists deal with historic claims and popular beliefs about the significance of indigenous agriculture prior to European Contact, when the physical evidence is weak? David Bernstein evaluated RI 193, the Greenwich Cove Site, based on work that began in 1979 and concluded with his extraordinary publication (Bernstein 1993). In 1993, after a very intensive evaluation of this coastal shell midden and an examination of archaeological evidence around Narragansett Bay Bernstein (1993:120) presented this position:

A complete absence of domesticates at sites along Narragansett bay . . . argues against horticulture as a major factor in the overall subsistence regime. This interpretation stands in direct contrast to European accounts . . . and suggests

Archaeological Sites with Maize:

- 1 RI 15 (1974)
- 2 RI 2050 (1994)
- 3 RI 110 (1994)
- 4 RI 1818 (1996)
- 5 RI 2080 (2003)
- 6 RI 2370 (2004)
- 7 RI 2390 (2006)



Figure 6-3. Locations of seven archaeological sites in Rhode Island with maize, ordered by year of discovery.

that the *intensification* of agricultural production may have been a postcontact development. (emphasis added)

Methodologically, the Greenwich Cove project used a variety of extraction—wet screen, dry screen and flotation—and several sampling techniques—random, systematic, bulk and selective—to collect a broad range of subsistence information. Bernstein’s research carefully describes the thousands of specimens of invertebrate and vertebrate species collected.

Bernstein also incorporated all of the then-known botanical and animal data collected from archaeological sites around Narragansett Bay. Very intensive excavation around Narragansett Bay throughout the 1980s and into

the early 1990s at a broad range of sites, again using many different wet and fine screen extraction procedures, supported his position. Prehistoric contexts did not contain domesticates. All of the contexts with domesticated plants, such as abundant maize at Fort Ninigret (Salwen and Mayer 1978) or a bean at RI 667 (Morenon 1986), were not unambiguously pre-European. They were either associated with European goods or dated later than ca. A.D. 1640. All of the evidence for agriculture available into the early 1990s could not refute the argument that “intensification of agricultural production may have been a post-contact development.”

However, conventional wisdom emphasizes the importance of maize, bean, and squash in Native American communities in coastal New England. Our social study

and history text books present this view. Most children “know” that the Pilgrims escaped from certain starvation because they adopted traditional Indian agricultural practices. Narragansett oral history certainly includes a historical past. Succotash, a traditional dish made from any number of ingredients, including maize, is seen as having ancient roots. Why not question it? The point raised by our scientist critics at the Sigma Xi presentation in March 2006 was, why question it?

Our experiences are that non-archaeological audiences do not appreciate the ambiguity or uncertainty that is so prevalent in disciplines, that develop research paradigms and evidence over decades. Archaeological research on the development of agriculture in Rhode Island is well over 30 years old and for much of this period there was no evidence to report, no maize found in features that dated prior to European settlement of the region. As in other disciplines, “exploring the unknown requires tolerating uncertainty” (Greene 2006: A23), but uncertainty is not always welcome.

To some audiences, questions about the importance or intensity of the “three sisters” around Narragansett Bay can be unsettling. For example, consider discussions around the development of an integrated science kit created for southern New England Indian themes. This kit was designed for elementary school science classes between 1991 and 1993 and has been widely distributed in southern New England. “How corny can you get?” is one of the four strands in “The Whole Kit and Kaboodle.” MacGregor Kniseley (2006) consulted with scientists. He talked with archaeologists who raised questions about the importance of the “three sisters.” He worked with Narragansett tribal members to create experiments built around maize and beans. Maize, bean, and squash remain central to the Native American curricula used by thousands of elementary school children around Narragansett Bay today.

Or, consider the response received in the mid-1980s as Morenon spoke one Saturday afternoon to elder Narragansett Indian leaders at a tribal council meeting. Council members were surprised, if not offended, when he mentioned that archaeological evidence indicated that maize occurred late and perhaps was not so important in their history. Their response was emphatic: “Corn has always been important.” Thus, there is considerable support by non-archaeologists, by the scientific and Native American community, for the centrality of agriculture around Narragansett Bay. This “centrist” position is not simply unsupported folklore. There is considerable non-archaeological evidence underlying the widely held view that maize and agriculture were important, prior to and at the point of European settlement.

EXAMINATIONS OF EARLY HISTORY AND LANGUAGE

First, the earliest European observer, Verrazzano wrote what many presume to be a description of Narragansett Bay during a two-week stay in Newport harbor in April 1524:

We frequently went five to six leagues [a league is approximately 2.4 miles] into the interior, and found it as pleasant as I can possibly describe, and suitable for every kind of cultivation—grain, wine, or oil. For there the fields extended XXV to XXX leagues; they are open and free of any obstacles or trees, and so fertile that any kind of seed would produce excellent crops. . . They live on the same as other people—pulse which they produce with more systematic cultivation than the other tribes . . . (Wroth 1970:139)

Verrazzano’s use of the word “pulse” introduces ambiguity into his observations of Native life around Narragansett Bay, as presently understood. We question what crop Verrazzano might have observed growing in the fields around Narragansett Bay, especially since he is purported to have passed through Newport in late April, before planting season. The original Italian word used in Verrazzano’s *Cellere Codex* is “legumi” (Wroth 1970:129). In modern Italian, “legumi” is not limited to legumes but can be translated as “vegetables.” Of particular interest is how the word was translated in Verrazzano’s time. Francesco Erspamer, Professor of Romance Languages and Literature, Harvard University, told us: “Strictly speaking, legumi means (and meant) legumes, pulses, that is edible seeds growing in pods. But very common is (and was) the extensive and inaccurate meaning, to include vegetables (as in French, “legumes verts”). Both meanings are listed in the Grande dizionario della lingua italiana, with examples from the fifteenth and sixteenth centuries” (Erspamer, personal communication, 2006). This information does not end the ambiguity. Verrazzano might have been writing about “vegetables” including maize, and not beans, specifically. Susan Tarrow, who translated the *Cellere Codex* into English, told us (S. Tarrow, personal communication, 2007) that she translated “legumi” as “pulse” (Wroth 1970:139), in keeping with the accepted meaning of the word.

Native peoples often cooked both beans (pulse/legumes) and maize kernels in a stew with added ingredients, such as meat and plant foods, when available. Beans might easily have been confused with maize kernels, if indeed Verrazzano actually observed these foods being prepared along the New England coast.

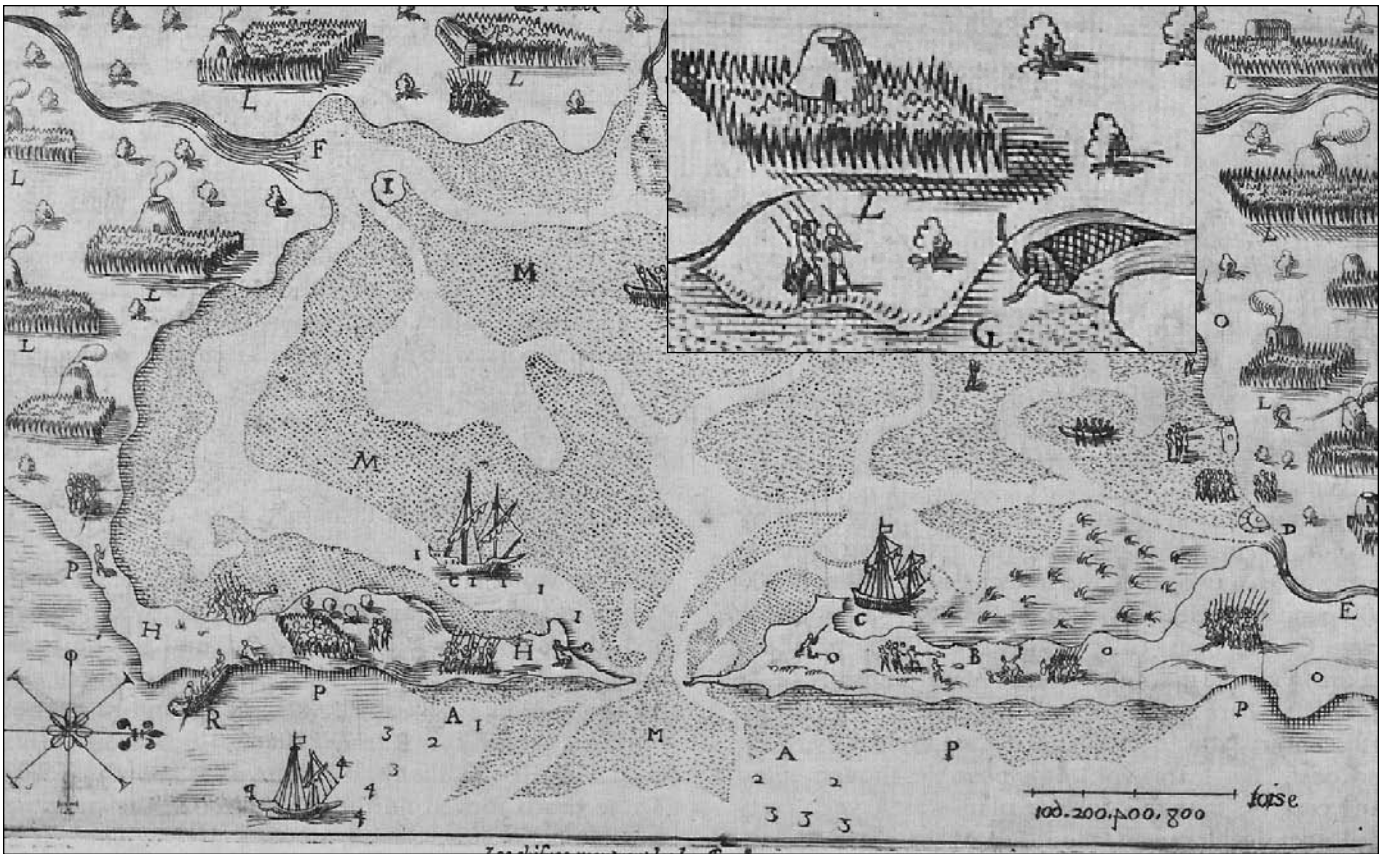


Figure 6-4. Champlain map of Nauset Harbor on Cape Cod in 1605, with enlarged detail (insert) of a house surrounded by a corn field. After Salwen 1978:165.

Carbonized maize from archaeological contexts can be misidentified as beans, as we have seen in our recent work to clarify the evidence around Narragansett Bay.

The linguistic evidence does not definitively establish what Verrazzano saw growing in the fields around Narragansett Bay in April 1524. He likely sailed along the coast before crops were planted. Verrazzano had already traveled up the East Coast from the Carolinas, observing landscapes, people and their practices. He stopped along the Hudson River, passed along the east coast of Long Island and passed around Block Island before entering Newport Harbor. Before he arrived in southern New England, he had considerable comparative evidence to describe the agricultural landscape he observed. It was cleared with extensive fields extending around the bay and into the interior. Their agricultural production was “more systematic” than he had observed elsewhere along the East Coast of North America. In April of 1524 (during the Little Ice Age), Verrazzano would have been looking at cleared surfaces, before the planting season.

A second observer, Champlain, visited Plymouth and Nauset (Chatham) harbors in coastal Massachusetts in the summer of 1605, his well-known Nauset map, as shown in Figure 6-4, depicts a fully agricultural land-

scape, with separated households surrounded by fields. The plants in his illustration appear to be maize. Although we have not looked at the original map, even the brushstrokes detailed in the insert in this illustration look like maize.

A third text recommended to us by Paul Robinson (personal communication, 2006) describes the English colonies extracting volumes of “corne,” through trade, from Narragansett Bay before large-scale European settlement had developed there. Winthrop, in November 1634 notes:

[November 5/5] The Rebecka came from Narigansett with 500: bz. [bushels] of Corne given to mr Io: Oldham: the Indians had promised him 1000: bz. But their store fell out lesse then they expected . . . This is a verve faire Baye beinge aboue 12: leags. square. With diverse great llandes in it: a deepe channel close to the shore beinge rockye: . . . The country on the west of the Baye of Narig. is all Champion [level open country] for many miles, but verve stonye, & full of Indians, he sawe there about 1000: men women &

children yet the men were many abroad on huntinge. (Winthrop 1996:132-133)

Here too we have to pay attention to the meaning of words. Was Winthrop using “corne” in its seventeenth century English meaning, as the locally grown seed crop? We do think that crop was maize. Based on the archaeological work at Fort Ninigret and the historical descriptive evidence, there is little reason not to assume that maize was intensively grown and probably traded by 1634 around Narragansett Bay. Here the archaeological evidence can help resolve disputed meanings of “corne.”

It is possible that Winthrop is describing indigenous farming practices that had just recently intensified in response to European demand for agricultural products. However, it is more plausible to see this as a description of people engaged in intensive agriculture, as well as involved in other (hunting) intensive subsistence practices, reflecting a mixed subsistence strategy that was still unfamiliar to European observers and historically ancient (see Chilton, this volume; Stein, this volume).

The complexity of agriculture around Narragansett Bay is well documented by 1643 in the fourth text, where Roger Williams through his analysis of Narragansett language describes where maize fits within the Narragansett culture. In addition to the oft-cited Narragansett creation story which includes a crow flying from Cautantowitt’s house with a seed of “corne” (maize) in one ear and a bean in the other, Williams describes the association between maize and beans, souls of men and women, and sacred directions:

Kautántowwit the great South-West God, to whose House all soules goe, and from whom came their Corne, beanes, as they say. (Williams 1973: 190)

Obs. They believe that the soules of Men and Women goe to the Sou-west, their great and good men and Women to *Cautántowwit* his House, where they have hopes (as the Turkes have) of carnall Joyes: Murthers thieves and Lyers, their Soules (say they) wander restlesse abroad. (Williams 1973:194)

Elsewhere (Morenon 2006a), Williams provides an inventory of words and phrases that connect maize, farming, and harvesting to many cultural details (Williams 1973:100–103, 121–122, 128, 164, 165, 167, 169–172, 190–191, 206–207, 210, 215, 231). Williams describes: types of dishes; types of people (maize and non-maize), types of household tasks and tools, types of labor (for women); seasonal cycles; abundance (pigeons and strawberries); tame animals (hawks to discourage predation); types of fields; varieties of maize; types of production—planting,

weeding, hoeing, harvesting, drying and storing; types of cooperation (between women, between women and men); many symbolic associations with maize—souls, fire, power (Manitou), feasts or dances (Nickómno), types of women’s productivity - value, marriage, fertility and child bearing, trade, and public gift exchange.

Williams’ narrative depicts maize, farming and agricultural details that were deeply imbedded in Narragansett everyday and esoteric thoughts and activities. He arrived in Providence in 1636 and published these detailed observations just six years later, in 1643. His text documents the presence of maize, bean, and other domesticates. His “Key into the Language” is an inventory of words, phrases, and pieces of speech that describe an agricultural society; his narrative is an agricultural ethnography that extended from creation to technology, from social organization to ideology.

Thus, the historic argument for intense production, for the centrality of maize, around Narragansett Bay includes descriptions of extensive agricultural landscapes from 1524 and large volumes of maize used in trade in 1634. It consists of a complex vocabulary collected between 1636 and 1643 of maize-based beliefs, activities, and institutions which certainly preceded European settlement. Agriculture could have intensified around Narragansett Bay after the arrival of Europeans, in response to new demands for indigenous foods, demographic pressures and competition over resources. However, the historical documents are consistent with an argument for intensive agriculture prior to European Contact. Agriculture was very important to indigenous peoples around Narragansett Bay before the first European settlers came shopping for some of its surpluses. Language is important to this discussion of intensification; the development of the many complex word meanings and cultural associations found in Narragansett speech by Roger Williams in the 1640s is itself evidence for the historical centrality of maize agriculture. Here is where a few maize kernels from recent archaeological work can provide new perspectives on a few ambiguous words noted in one or two texts and contribute to the way linguists and historians interpret those words. Language is culture; words have meaning, as do features, artifacts, and seeds.

TRADITIONAL NARRAGANSETT FOOD PRACTICES

Archaeological work conducted over the past few decades indicates that there were great regional subsistence differences within Rhode Island. The Narragansett, as is the case for many New England Algonquian speakers, moved residences seasonally to exploit their whole habitat. They were shellfish gatherers in some locations;

maritime hunters, fishermen, large-game hunters, plant gatherers, and silvaculturalists in other locations. Also they were farmers or horticulturalists, primarily on the coastal plain and along the edges of rivers. All sorts of activities were concentrated along the coastal edges. The historic data do not present peoples who lived in large concentrated villages and essentially depended on maize, supplemented by natural products.

Rather, the historical data indicate that while maize production was an essential part of their culture, other subsistence strategies were also intensively pursued. Many of these practices have great time depth, and some do not. Sea mammals were extracted in some locations such as Block Island, but not others. At RI 193 (Bernstein 1993) the shellfish species collected varied as the nearby estuary changed, perhaps due to rising sea levels. At RI 667 and RI 670 (Morenon 1986) woodland plant materials such as hickory nuts are found in features over a 4,000-year period and were contained in large storage pits 2,000 years ago. Other plants such as sassafras appear later, perhaps reflecting habitat changes associated with the intensification of agricultural practices. Rhode Island is a small state. Just a few miles separate RI 193, RI 667 and RI 670, the average distance to the coast from any random location in Rhode Island is only 13 kilometers (8 miles). All of the indigenous peoples would have had direct or indirect access through social exchanges, to the varied habitats, as well as access to the varied natural and domesticated food resources available around Narragansett Bay.

IS THERE NOW ARCHAEOLOGICAL EVIDENCE FOR INTENSIVE PRE-EUROPEAN AGRICULTURE?

In January 2006 Largy reviewed all of the maize evidence from Rhode Island at a meeting held at the Public Archaeology Laboratory, Inc., in Pawtucket, Rhode Island with archaeologists involved in the recovery of maize from Rhode Island sites. In addition to Largy and Morenon, the group included PAL archaeologists Alan Leveillee and Joseph Waller, and Charlotte Taylor from the Rhode Island Historic Preservation and Heritage Commission (RIHPHC). The samples of maize were examined by Largy and photographed by Waller. Taylor elected to bring a sample which included 16 maize kernels and one scutellum out of approximately 280 kernels recovered by Salwen and Mayer in the 1970s (Mayer n.d.; Salwen and Mayer 1978). Figures 6-1 and 6-2 illustrate some of what we observed and recorded at this meeting.

Largy identified 31 charred maize fragments representing 26 kernels and an additional five fragments exhibiting recent breaks from six archaeological sites, as noted in Table 6-1. In some cases, Largy simply confirmed what

others had previously described as maize. In one case a specimen previously described as a carbonized bean was confirmed as maize, and in several cases Largy rejected previous maize identifications.

This examination demonstrated what many archaeobotanists well know: These few specimens available for study represented many specimens lost to study. One maize fragment found at a site undoubtedly means many more are present at that location. The charred botanical specimens Largy observed with recent breaks indicate that breakage occurred either during or post-excavation. While some fragments slip through screens with mesh sizes that are too large, others are recovered in wet screens or flotation but not recognized.

Smaller bits of maize kernels can be identified if some part of the outermost seed coat, bearing diagnostic striations, is preserved. However, these structures are best recognized through low-power magnification. Thousands of liters of sediment may be recovered from excavations, but all are not processed. The recovery rates can be improved; trained specialists need to look carefully for the few maize kernels that are preserved in these samples.

The systematic examination of all the known maize specimens also convinced the assembled scholars that maize was extensively present in Rhode Island. Expertise, time and money are required to improve recovery, but expectation and anticipation are also necessary. Agreeing that maize is present and can be extracted from pre-European archaeological sites changes expectations.

Since the initial overview in January 2006, one more maize kernel from a dated feature at a seventh archaeological site (RI 2390) has been confirmed by Largy (Waller and Leveillee 2006:43) and was added to the inventory (Table 6-1). One AMS date directly from a maize kernel at RI 2370 (110 ± 70 B.P.), two other AMS dates from maize at RI 15, Fort Ninigret (360 ± 40 B.P., 340 ± 40 B.P.), and three dates from features containing maize at RI 110 (700 ± 70 B.P., 1000 ± 40 B.P., 630 ± 40 B.P.) were also added in October 2006 to this inventory.

In January 2006 we also sought one other reported maize sample, a carbonized cob described in the Roger Williams Park Museum (Morenon 1984:74). Case number 478 in that museum assessment study was from a "general RI context." Conversations with the current museum curator (Massaro, personal communication, 2006) indicate that this sample was probably from southern Canada and not from Rhode Island. When sample sizes are small, it is important to confirm or deny each specimen.

WHAT IS THE PHYSICAL EVIDENCE?

These few kernels represent a modest record from seven archaeological sites, which are organized in Table 6-1 by

Table 6-1. Archaeological Sites with Early Maize in Rhode Island (2006)

Date Found	Site	Description of Maize	Context	Material Dated	Radiocarbon Age (B.P.)	Cal. 2 σ range (A.D.)	Comments	Sources
1974	RI 15 Fort Ninigretc	280 complete	Stratigraphic, recovered in flotation Contact, a “greasy” level with corn may predate European contact	Maize	360±40 340±40	1450–1635 1462–1642	Site on state land; continued research possible	Salwen & Mayer 1978; Mayer n.d., Taylor 2006
1994	RI 2050	1 complete 1 in 6 fragments	Feature 1, from two levels recovered in wet screen and in field	Charcoal	910±110	896–1284	Phase III; site partially eliminated	Handsman 1995; Waller and Leveillee 1998
1994	RI 110	5 complete	Feature 201, 206, 208, 211 and 441; recovered in flotation and excavation	Feature 201 Charcoal, Shell Feature 206 Charcoal Feature 211 Charcoal	770±70 1000±40 720±40 630±40	975–1155 1047–1390 1221–1386 1285–1401	Phase III; development interrupted; research to continue	Leveillee and Harrison 1996; Waller 2000
1996	RI 1818	1 complete	Feature 3, recovered in flotation	None	—	—	Phase III; research possible	Begley and Leveillee 1996
2003	RI 2080	1 complete	Feature 267, recovery uncertain	Charcoal	530±70	1286–1481	Phase III; site eliminated	Leveillee 2005; Leveillee, Waller & Ingham 2006
2004	RI 2370	1 complete 1 monocot stem (2 fragments)	B horizon, recovered in wet screen with flakes	Maize	110±70	1667–1954	Phase I; research uncertain	Morenon 2006b

the year in which maize was first discovered at each location. Note that not every specimen was initially described as maize. So, in some cases it was not until 2006 that disputed descriptions were finally resolved by a group of scholars reviewing all of the available evidence. Each site deserves a brief unique description; each place is a case study unto itself.

1. *RI 15*. Fort Ninigret is both an archaeological site and a state owned historic property that is located on the edge of a salt pond in Charlestown, Rhode Island. Salt ponds are ubiquitous features along Rhode Island's Atlantic Coast and Ninigret Pond represents an important natural habitat. Parts of Ninigret Pond are protected by the U.S. Fish and Wildlife Service. Native peoples concentrated land uses and communities around these ponds in the past. Until recently, Euro-American farmers exploited the productive, flat, outwash plains that surrounded Rhode Island's salt ponds. Today, these ponds and the surfaces around them are preferred tourist destinations and under great development pressure.

The two AMS dates of 360 ± 40 B.P. (cal. 2σ A.D. 1450–1635) and 340 ± 40 B.P. (cal. 2σ A.D. 1462–1642) on maize that are reported here are the first absolute dates for Fort Ninigret. They also are the first AMS dates on maize in Rhode Island. Both dates are consistent with earlier estimates that this site dated to the early 1600s based on associated European trade items. These dates also support arguments that activities began before and continued into the early European era, with its fortification and trading post. Many sites in Rhode Island have a long human record. The new radiocarbon evidence indicates that greater precision to the historic timing of activities is possible at Fort Ninigret through additional dating of existing and new evidence.

Finding ancient alongside recent evidence is to be expected. As an historic property this site was modified through the addition of embankments to enhance its popular appeal in the last century. Thus, the excavations in the 1970s (Salwen and Mayer 1978) and into the 2000s (Taylor 2006) had to unravel a complex landscape of features, surfaces, and post-site modifications. The more than 280 maize kernels reported for this location, as well as the preserved features and surfaces that still exist, do document an important place, a site at which indigenous and European technologies, values, and communities connected. Fort Ninigret still contains important evidence; this is a place where the relative intensity of agriculture from the 1400s into the 1600s can be evaluated. Future studies, including the syn-

thesis of available samples and records from decades of archaeological research at this location are anticipated.

2. *RI 2050*. Located on alluvial terraces and overlooking a broad floodplain parallel to Furnace Hill Brook in the town of Cranston, RI 2050 was discovered during an archaeological survey for a federally funded roadway widening project. Subsequent intensive testing and data recovery isolated buried features there. RI 2050 is another location where human activity occurred over thousands of years. Soapstone debris, perhaps extracted from the nearby Oaklawn Soapstone Quarry (RI 47), is well represented in the material record at RI 2050. Feature 1 contained two maize kernels, recovered from two levels. This feature has a 910 ± 110 B.P. (cal. 2σ A.D. 896–1284) date on charcoal, which is both the first and currently oldest date for a feature containing maize in Rhode Island. The first maize specimen was recovered in a wet screen. The second specimen was found in situ in this feature. Initially researchers debated whether the carbonized seeds were maize. These specimens were first described as maize in 1998 (Waller and Leveillee 1998). That description was confirmed by Largy in 2006, based on recognizable attributes for Northern Flint maize. Parts of this site were removed in the alterations to Phenix Avenue, but some other portions remain and are protected as part of the road right of way. Some of the information from this site will be further studied as part of a doctoral dissertation.
3. *RI 110*. An archaeological survey of a proposed private development along a coastal edge on a salt pond that required a permit from a state agency, the Coastal Resources Management Council, located what appeared to be a large Narragansett village. This location on Upper Point Judith Pond in Narragansett had been described as a probable village in documents from the 1930s. During subsequent data recovery in which 11 percent of the site was studied, maize was removed from five dated features, three of which had charcoal dated between 1000 ± 40 B.P. (cal. 2σ A.D. 975–1155) and 630 ± 40 B.P. (cal. 2σ A.D. 1285–1401). That RI 110 contains dozens of household residences, thousands of features, burials, as well as utilitarian and sacred objects came as no surprise to the Narragansett Indian Tribal Historic Preservation Officer, or to the historic preservation community that has reviewed this project over the past decade. In 2008 fieldwork continues on this imposing site and controversial project. Forty modern houses are proposed on single family lots and archaeologists are now at work identifying and studying exposed features, lot by

lot. The synthesized botanical evidence reported here has been integrated into the justification for continued research at this site.

4. *RI 1818*. This site was located during a development project in South Kingstown involving wetland review and management. Feature 3 was discovered during limited data recovery and contained one maize kernel, extracted from a flotation sample. This feature or specimen has not been dated. The opportunity for continued research at this location is uncertain.
5. *RI 2080*. A survey of a private development project, proposed near another salt pond, Quonochotaug Pond in Charlestown, segregated those parts of the project area with high from those areas with low archaeological potential. Subsequent limited machine stripping in the areas presumed to have the greatest sensitivity identified post molds and other features. Research was limited. Feature 267 contained one maize kernel and was dated on charcoal to 530 ± 70 B.P. (cal. 2σ A.D. 1286–1481). This site, identified as a formative village (Leveillee 2005) was only partially examined. It has been eliminated from further field study, although additional studies of existing samples and collections could occur.
6. *RI 2370*. In the winter of 2005 a small survey was completed on private land on the edge of Narragansett Bay in Warwick, Rhode Island. A landowner had proposed to subdivide his property and agreed to an archaeological study to document its archaeological potential. In order to secure a permit from the City of Warwick to subdivide this property this landowner agreed to a modest archaeological survey. One maize kernel and a carbonized monocot stem were recovered in the wet screening of a frozen sediment sample from a test excavation. Although this sediment came from the B Horizon in association with stone artifacts, the AMS date of half of this kernel of 110 ± 40 B.P. (cal. 2σ A.D. 1667–1954) is ambiguous. Radiocarbon date accuracy is tenuous for samples that fall between 80 B.P. and 200 B.P.; calibrated dates in this range yield varied results. No further study of this site will be allowed.
7. *RI 2390*. In 2006, an archaeological survey with subsequent data recovery in North Kingstown, Rhode Island, was completed near RI 1000, a seventeenth century Narragansett Burial Ground that was studied in advance of a private development project using National Park Service funding and in collaboration with the Narragansett Indian Tribe (Brown and Robinson 2006) and RI 667, an intensively studied site that was completed as part of a federally funded highway project (Morenon 1986). The sever-

al studies completed in a relatively limited area do provide a long archaeological record, with a radiocarbon sequence extending over 3,000 years at this location. RI 2390 contains one maize kernel and an associated date on charcoal of 410 ± 50 B.P. (cal. 2σ A.D. 1421–1634) from Feature DB11. Parts of this site are to be preserved, but opportunities for future research there are uncertain.

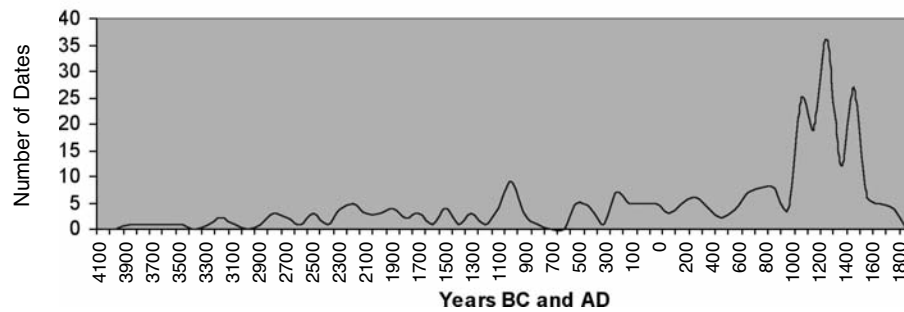
WHAT DO WE NOW KNOW?

There is growing consensus that places with carbonized maize are broadly distributed near the coastal edge within management areas in Rhode Island that are called the “coastal zone” and “near interior.” Although many of the large and complex sites with maize are on the edges of salt ponds, or just a few meters from mean high tide, RI 2050 is on a terrace overlooking a small stream valley 8,000 meters from salt water. Attention here is paid to development and preservation issues because all of the research in Rhode Island is based on Cultural Resource Management studies. Research, therefore, occurs in those places where development pressures are the greatest. Locations that are less subject to development pressure or are not protected by federal, state, or town statutes are rarely studied. Thus, one can not assume that inland locations were not farmed prior to the arrival of Europeans simply because maize has only been found along the coastal edge in studies completed over the past 30 years. As we have discovered, no evidence can lead to different conclusions.

For ancestors of the Narragansett Tribe, the intensity of farming and community life was undoubtedly greatest in, although not limited to, the coastal margins. They concentrated in the same locations as human activity concentrates today. Thus, the current evidence for maize agriculture in the pre-European archaeological data supports the historical descriptions presented first by Verrazzano and later by Williams of intense farming in the coastal zone of Rhode Island in the A.D. 1500s and 1600s.

Development pressures today are greatest on the most complex sites, including those where the evidence for agriculture is most evident. Sites such as RI 15, Fort Ninigret, and RI 110, are on the edges of coastal salt ponds. These sites have the greatest concentrations of maize recovered to date from pre- and post-European contexts. Many of the archaeological sites in these coastal settings are now treated as large villages. Each could contain thousands of features, which are only modestly sampled in data recovery studies. These are locations where it must be presumed that domesticated plant remains are present. However, these complex sites are very costly to study. Even when sediment is collected in detailed studies of

Calibrated Radiocarbon Dates by Century in Rhode Island



Site	Radiocarbon Age (B.P.)	Lab Number	Dating Details	Cal 2 σ range (A.D.)
1. RI 15 (Fort Ninigret)	360 \pm 40	Beta 221206	AMS on maize	1450–1635
	380 \pm 40	Beta 221207	AMS on maize	1462–1642
2. RI 2050	910 \pm 110	Beta 79659	Charcoal from Fea 1	896–1284
3. RI 110	770 \pm 70	Beta 92196	Charcoal from Fea 201	975–1155
	1000 \pm 40	Beta 221662	Shell from Fea 201	1047–1390
	720 \pm 40	Beta 221663	Charcoal from Fea 206	1221–1386
	630 \pm 40	Beta 221665	Charcoal from Fea 211	1285–1401
4. RI 1818	None			
5. RI 2080	530 \pm 70 BP		Charcoal from Fea 267	1286–1481
6. RI 2370	110 \pm 40 BP	Beta 221208	AMS on maize	1667–1954
7. RI 2390	410 \pm 50 BP		Charcoal from Fea DB 11	1421–1634

Figure 6-5: 279 calibrated radiocarbon dates from all Rhode Island sites plotted by century from 4100 B.C. to A.D. 1900, and all calibrated maize dates.

these locations, those samples are not always completely studied, due to funding constraints. Logic would suggest that our efforts should be greatest where new knowledge can be gained. Unfortunately, agencies do not enjoy funding what is unknown, nor are they eager to support studies of complex archaeological sites where evidence is often abundant and unexpected discoveries are likely. Funding agencies do not easily tolerate uncertainty.

The timing of all of the maize currently found and documented in Rhode Island is consistent with a pre-European onset. All of the available evidence for maize falls within the last 1000 years (Table 6-1). The potential interpretive value of the small sample of maize dates (Figure 6-5) is magnified when this evidence is combined with other bodies of evidence, such as the distribution of all ^{14}C dates from Native American features in Rhode Island.

The number of dates from all Rhode Island archaeological features in sites quadrupled after cal. A.D. 1100, as shown in Figure 6-5. Midpoint calibrated dates from features range between 12 and 36 per century from cal. A.D. 1100 to 1599 and from 0 to 8 per century from cal. 3900 BC to A.D. 1099, and after cal. A.D. 1600. All types of features are included in this record: hearths, storage pits, post-molds, and more. The dates that are compiled in Figure 6-5 were previously presented in conventional form (Morenon 1998; Robinson 2002: 46). Converting those

conventional dates to calibrated dates does not change previous conclusions, although it does concentrate a few more dates between cal. A.D. 1100 and 1600 than previously shown. More importantly, using calibrated dates facilitates discussions with disciplines that use historical dating scales.

Human activity, as measured by the number of dated features per century (Figure 6-5), intensified near Narragansett Bay between cal. A.D. 1100 and cal. A.D. 1600. Human activity, as reflected in dated Native American features, slowed down after cal. A.D. 1600. This intensification occurred in all parts of Rhode Island. Although not shown here, this intensification of feature dates is most extreme in locations closest to the coast. These curves help us identify significant historical events at the upturn in cal. A.D. 1100 and downturn in cal. A.D. 1600 that require explanation. All the mid-point calibrated dates on maize and features containing maize (Figure 6-5) occur after cal. A.D. 1100, a point at which human activity, as measured by the number of ^{14}C dates from archaeological features, intensified; again increasing from 1 to 8 features per century for 4,000 years to 12 to 36 dated features between cal. A.D. 1100 and 1600.

Thus, the questions raised at the start of this essay must now be restated. It does appear that human activity intensified several hundred years prior to the arrival of Europeans on the shores of Narragansett Bay. The ques-

tion we now wish to raise is: How is maize agriculture associated with a period of intensification of human activity after cal. A.D. 1100 around Narragansett Bay? The new body of evidence compiled since January 2006 should be used to critically examine a number of important claims, not only about the development of maize agriculture, but also about possible associated ecological, demographic, social, and political shifts. These complex shifts occurred throughout New England (Chilton 2005: 155). They are not restricted to Narragansett Bay. While well beyond the scope of this paper, one could argue that the Narragansett people were in a period of great cultural florescence; a dynamic period of societal and regional growth in the cal. A.D. 1100s, followed by stability for the next 400 years. This stable period came to a crashing halt shortly after Verrazzano appeared in Newport Harbor in 1524. People living around Narragansett Bay still live with the consequences of that crash (Brown and Robinson 2006:63). We have argued that this new evidence is consistent with existing linguistic and historical evidence and interpretations. The children of Rhode Island can now rest at ease, Indian agriculture was central to community life for hundreds of years before the Pilgrims arrived.

WHERE DO WE GO FROM HERE?

We are not in agreement about how far to extend the existing evidence. However, at this point some directions are clear. It is clear that the presence of domesticates, from pre-Contact Narragansett villages, farmsteads, and work areas, in seven locations, are extensively distributed around Narragansett Bay (Figure 6-3). One site, RI 2370, contains carbonized maize with an ambiguous AMS date 110 ± 40 B.P. (cal. 2σ A.D. 1667–1954). Six other archaeological sites contain unambiguous evidence of maize from pre-European features (Table 6-1). Fort Ninigret (RI 15) is in a state park, which provides some protection and offers opportunities for its continued study. That site now has two AMS dates on maize of 360 ± 40 B.P. (cal. 2σ A.D. 1450–1635) and 340 ± 40 B.P. (cal. 2σ A.D. 1462–1642). Thus, the argument for pre-European maize agriculture at Fort Ninigret appears to be supported. Whether a Dutch fort was built on an earlier indigenous village or within a pre-existing settlement cannot be determined from this new evidence alone. The remaining five sites with maize have been studied as cultural resource management projects. One large pre-European coastal village site, RI 110, has five features with maize with four dates between 630 ± 40 B.P. (cal. 2σ A.D. 1285–1401) and 1000 ± 40 B.P. (cal. 2σ A.D. 1047–1390). Data recovery for a proposed housing development there has exposed dozens of structures of varying size and shape and hundreds of features. We now know that archaeological sites with maize

occur within a few hundred meters of mean high tide to several kilometers inland. One, RI 1818, occurs along a small inland stream. Parts of this site have been preserved within a road right-of-way. All of this pre-European maize evidence from archaeological sites in Rhode Island is consistent with the historic record

Whether the intensification of agriculture was responsible for the settlement shifts and concentration of human activity around Narragansett Bay after cal. A.D. 1100 remains to be argued. How subsistence evidence connects to other lines of evidence for intensification needs to be developed. Furthermore, the mixed Algonquian subsistence pattern, including broad based farming, may well have intensified further after the arrival of Europeans, when indigenous population numbers collapsed and communities were pushed off the coastal margins. It is clear that conclusions made by archaeologists and archaeobotanists on the basis of no evidence must be revised. We should not wait another thirty years to systematically work together.

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CHAPTER 7

EVOLVING THE THREE SISTERS: THE CHANGING HISTORIES OF MAIZE, BEAN, AND SQUASH IN NEW YORK AND THE GREATER NORTHEAST

by John P. Hart

The "three sisters," maize (*Zea mays* ssp. *mays*), bean (*Phaseolus vulgaris*), and squash (*Cucurbita pepo*), were the dominant crops in many Northeast Native American agricultural systems during the late prehistoric and historic periods (Hurt 1987; Trigger 1978a). The histories of these crops have long been of interest to archaeologists because it is often thought that their adoption and the intensification of their production were important in the developments of cultural traits evident in the late prehistoric archaeological record and recorded by early European chroniclers. For example, the development of matrilineality, matrilocality, and longhouses, key traits of northern Iroquoian groups, has been thought by some to have developed with the increasing importance of female agricultural production (e.g., Trigger 1978b). Alternatively it has been suggested by others that Iroquoian migrants brought maize-based agriculture to New York and that this helped them to displace non-agricultural Algonquian groups (e.g., Snow 1995). New England archaeologists, on the other hand, have debated for years the significance of maize's adoption for regional subsistence-settlement systems and have often contrasted the New England archaeological record with that of New York (e.g., Bendremer 1999; Bernstein 1999; Ceci 1979-80; Chilton 1999, 2002, 2006, this volume; Demeritt 1991; Petersen and Cowie 2002; Snow 1980; Stein, this volume).

As can be seen in many of the chapters in this volume, as well as in Hart (1999a) and Hart and Rieth (2002), the adoption and intensification of maize-based agriculture are primary topics of interest among archaeologists and paleoethnobotanists working on late prehistoric times in the Northeast. The histories of maize, bean, and squash have been the subject of an on-going research program for the past decade by me and several colleagues (e.g., Hart 1999b, 1999c, 2000a, 2001, 2003, 2004, 2007; Hart and Asch Sidell 1996, 1997; Hart and Brumbach 2003; Hart and Scarry 1999; Hart et al. 2002, 2003, 2004, 2007a, 2007b,

2008; Thompson et al. 2004). In this chapter, I summarize the results of that research to date. I also provide brief overviews of three models that I believe can contribute to our understandings of the histories and evolution of maize-bean-squash agriculture in the Northeast and of the nature of the evidence we use to explore the histories and evolution of the triad.

SETTING THE STAGE

Polycropping maize, bean, and squash has a long history in the Western Hemisphere. Evidence for each of these crops extends back millennia in Central and South America (e.g., Dillehay et al. 2007; Kaplan and Lynch 1999; Piperno and Flannery 2001; Smith 1997) while there are much shorter histories in the North American Southwest, Plains, and East (e.g., Adair 2003; Asch and Hart 2004; Fish 2003; Schneider 2002). However, it does appear that whenever these three crops were available, they were in some manner grown and eaten together (Mt. Pleasant 2006). In fact soon after Europeans arrived in the Western Hemisphere, the three crops were transplanted to Europe and Africa, where they were also often grown and eaten together (e.g., McCann 2004; Paris 2000; Paris et al. 2006; Rebourg et al. 2004; Zevon 1997).

As noted by Mt. Pleasant (2006), there may be both agronomic and dietary benefits to the polycropping system of maize-bean-squash. Agronomically, each of the three crops may benefit the others when grown together (but see Park et al. 2002). Maize competes well against weeds and acts as climbing poles for bean vines. As legumes, bean plants fix nitrogen through symbiotic relationships with bacteria (Bernai et al. 2004). This nitrogen may be made available to the other plants (Giller et al. 1991; van Kessel and Hartley 2000), especially when remnants of bean plants are worked into the soil each year

(Mt. Pleasant 2006:536). Squash plants grow rapidly along the ground, and their large leaves act as mulch, preserving soil moisture and suppressing weeds. By mimicking natural plant communities, polycultures, such as maize-bean-squash, can be more stable than monocultures; they may withstand stochastic climatic events better than monocultures. By using nutrients, light, and water more efficiently than monoculture systems, agricultural productivity may be higher (per unit area) than monocultures (Mt. Pleasant 2006; Tsubo and Walker 2004; Willey 1990; Wooley and Davis 1991; but see Parker et al. 2002). The ability of farmers to take advantage of polycultures depends on their knowledge of each crop and each crop's interactions with the others within specific environments (Mt. Pleasant 2006; Wolley and Davis 1991).

Each of the crops also provides complementary value to diets (Mt. Pleasant 2006). Maize is high in calories but relatively low in protein and is deficient in two critical amino acids. Bean, on the other hand, is a rich source of protein, and has an amino acid profile that complements maize. Eating the two crops together provides a complete array of amino acids (Kaplan 1965). Squash is high in calories, vitamins, and minerals and its seeds are good sources of protein and oil (Robinson and Decker-Walters 1996).

There are, then, good proximal reasons why these three crops were frequently grown and eaten together. However, this does not explain their joint occurrences and uses. Each of the crops has separate evolutionary and dispersal histories. It is necessary to understand these histories in order to build explanations of the evolutions of the polycultural systems and the impacts of the crops on regional subsistence-settlement systems. I will briefly review the history of these crops in the Northeast generally and New York specifically, and follow this by a consideration of models that may help in building future explanations for the crops' histories in the various regions of the Northeast.

CROP HISTORIES

New macro- and microbotanical evidence and suites of accelerator mass spectrometry (AMS) dates directly on macrobotanical crop remains and charred cooking residues containing microbotanical remains are transforming our understandings of the histories of the three crops.

Cucurbita pepo

The earliest of the "three sisters" in the Northeast are cucurbits, commonly referred to as gourds and squashes. Gourd refers to a fruit that is generally small and extremely bitter and thus unpalatable, and squash refers to a palatable fruit that unlike a pumpkin is not round (Paris

2001:75). Current genetic evidence indicates that the squashes present in eastern North America prior to the European incursion had evolved in the East from *Cucurbita pepo* ssp. *ovifera* gourds native to the lower Mississippi drainage (Decker-Walters et al. 1993, 2002; Paris et al. 2003; Sanjur et al. 2002). These squashes included various summer squashes as well as acorn squash. The earliest published evidence for these gourds is at the Page-Ladson site in Florida. A direct AMS date of $12,570 \pm 100$ B.P. (cal. 2σ 15,105–14,234 B.P.) was obtained on a gourd seed, but it is not clear that the gourds were related to human use (Newsom and Muhlbachler 2006:268; Newsom et al. 1993:77–79). Older seeds of *Cucurbita* have been recovered from the Latvis-Simpson also in Florida AMS dated to $31,900 \pm 400$ B.P. and $31,610 \pm 240$ B.P. (Muhlbachler et al. 2002:291; also see Newsom and Muhlbachler 2006:323), although detailed descriptions of these seeds have not been published to date. At both sites, the seeds were associated with mastodon remains.

The earliest evidence in the East for gourd use by humans comes from Illinois and Tennessee where charred rinds and seed fragments have been directly dated to a few centuries on either side of 7000 B.P. (Asch and Asch 1985; Smith 1992). The earliest evidence in the Northeast comes from the Sharrow Site in Maine, where a rind fragment was directly dated to 5695 ± 100 B.P. (cal. 2σ 6717–6295 B.P.) (Petersen and Asch Sidell 1996). Rind fragments from the Memorial Park site in central Pennsylvania were directly dated to 5404 ± 556 B.P. (cal. 2σ 7338–4875 B.P.). The large standard deviation of this date is offset by a wood charcoal and three bulk soil sample dates from the same deposit that have a mean pooled age of 5009 ± 53 B.P. (cal. 2σ 5900–5644 B.P.) (Hart and Asch Sidell 1997). More recently, Monaghan et al. (2006) report the recovery of a gourd rind fragment from Marquette Viaduct in Michigan, which was directly dated to 3840 ± 40 B.P. (cal. 2σ 4411–4103 B.P.). Thus, the evidence for early gourd use in the Northeast, although compelling, is nonetheless sparse. The wide geographic distribution of the remains, however, suggests that the finds are not isolated cases (Hart and Asch Sidell 1997), and that additional finds will be made in the coming years.

The evidence for early squash use in the Northeast is also sparse. Based on current evidence in the East, it appears that squashes had evolved by cal. 5000 to 3000 B.P. and spread fairly rapidly (Monaghan et al. 2006). In the Northeast, squash rind fragments were directly dated to 2625 ± 45 B.P. (cal. 2σ 2852–2545 B.P.) at the Memorial Park site in Pennsylvania (Hart and Asch Sidell 1997). Monaghan et al. (2006; Lovis and Monaghan, this volume) report a direct date of 2820 ± 40 B.P. (cal. 2σ 3064–2803 B.P.) on an uncarbonized squash seed from the Green Point site in Michigan. It is not clear if this seed represents *Cucurbita*

pepo ssp. *ovifera* or *Cucurbita pepo* ssp. *pepo*, the Mexican subspecies. Hart et al. (2003; 2007b) and Thompson et al. (2004) report the recovery of squash phytoliths from charred cooking residues adhering to the interior surfaces of a pottery sherds from several New York sites. A residue with squash phytoliths from the Scaccia site was directly dated to 2905±35 B.P. (cal. 2σ 3205–2947 B.P.). Adovasio and Johnson (1981:72–73) report the recovery of an uncarbonized seed fragment from the Meadowcroft Rockshelter in southwestern Pennsylvania in a stratum bracketed by radiocarbon dates on charcoal of 2820±75 B.P. (cal. 2σ 3157–2768 B.P.) and 2815±80 B.P. (cal. 2σ 3158–2762 B.P.). Another uncarbonized seed was recovered from a higher stratum at this site with wood charcoal dates between 2134±65 B.P. (cal. 2σ 2321–1951 B.P.) and 2075±125 B.P. (cal. 2σ 2343–1740 B.P.). It is not clear if these seeds are from gourds or squashes, but given the dates, squash seems likely. What is clear from this evidence is that edible squashes were present in the Northeast by the end of the third millennium B.P., while gourds were in use at least two millennia earlier.

An important variable in the spread of gourds well into the Northeast, presumably through human mediation, is the fact that the flesh of these gourds is extremely bitter and inedible. The question then becomes, why would people have made use of these fruits over such a large region, extending well beyond their probable natural range? Two hypotheses are that the seeds were processed for consumption through the removal of seed coat bitterness (e.g., Cowan and Smith 1993) and that the dried fruits were used as floats for fishnets (e.g., Fritz 1999). Recently conducted experiments indicate that both uses are feasible (Hart 2004; Hart et al. 2004). Another possibility is that a non-bitter morph was discovered and isolated from gene flow with gourd populations with bitter flesh. Isolation from gene flow would have been necessary because bitterness is a dominant trait. If farmers relied on seed stock from the previous year's crop, cross pollination between gourds and squashes would result in ruined squash crops because the bitterness would be expressed in the F₁ generation (Robinson and Decker-Walters 1996:32–33). Asch (1994:41) identified a non-bitter gourd population in the Red River valley of Arkansas. "Either Red River farmers all formerly grew non-bitter gourds, which escaped, or more likely there is a pronounced founder effect and the present population has descended from a single lineage" (Asch 1994:41). In the terminology used here, this population would be classified as squash. This population must have been genetically isolated from the more common bitter gourd populations. Interestingly, there is ethnohistoric documentation of a small sweet squash referred to as vine apple because of its size (Trumbull 1876). Perhaps this is analogous to the first cucurbits with edible flesh in eastern

North America.

The fruits of *Cucurbita pepo* squash are highly polymorphic with a lengthy list of current cultivars (Paris 2001; Robinson and Decker-Walters 1996). This phenotypic variation reflects genetic variation that has arisen over millennia of crop population interactions with human populations. Important in the evolution of squashes was selection for non-bitter flesh, delay in lignification of the rind, and consequently increased fruit size.

Zea mays ssp. *mays*

Current evidence indicates a lengthy history for maize in the Northeast as well. Adovasio and Johnson (1981) reported the recovery of a maize cob fragment from Meadowcroft Rockshelter in Pennsylvania in deposits bracketed by radiocarbon dates on charcoal of 2325±75 B.P. (cal. 2σ 2700–2147 B.P.) and 2290±75 B.P. (cal. 2σ 2683–2069 B.P.). No direct dates on maize macrobotanical remains have approached these early ¹⁴C ages, and the Meadowcroft evidence is generally discounted in discussions of maize history in eastern North America (see MacConaughy, this volume; Smith 1992). However, the calibrated 2σ ranges of two early dates from Ohio overlap those of the Meadowcroft dates. Maize macrobotanical remains from the Edwin Harness site in Ohio (Ford 1987), have direct AMS dates of 2077±70 B.P. (cal. 2σ 2304–1881 B.P.) and 2017±50 B.P. (cal. 2σ 2115–1875 B.P.). Somewhat later, the Grand Banks site in southern Ontario yielded maize remains that were directly AMS dated to 1730±85 B.P. (cal. 2σ 1861–1416 B.P.) and 1720±105 B.P. (cal. 2σ 1872–1403 B.P.) (Crawford et al. 1997). The earliest published directly dated maize macrobotanical remain in New York is 1050±50 B.P. (cal. 2σ 1166–833 B.P.) (Cassedy and Webb 1999). In New England, the earliest direct date is from Massachusetts at 960±30 B.P. (cal. 2σ 929–795 B.P.) (Chilton 2006). There are a number of additional pre-1000 B.P. ¹⁴C ages on wood charcoal spatially associated with maize remains in northeastern North America that may provide further evidence of early maize in the region (see Crawford and Smith 1997:114). However, because of the vagaries of site formation, these early ages must be substantiated through direct AMS dating (see Conard et al. 1984; Hart 1999c).

In a series of articles, my colleagues and I have reported on results of analysis of phytoliths extracted from directly AMS dated charred cooking residues removed from the interior surfaces of pottery sherds (Hart et al. 2003, 2007b; Thompson et al. 2004). The majority of sherds are from sites in the northern Finger Lakes region of New York. Our analyses suggest that maize was being cooked in pots by 2270±35 B.P. (cal. 2σ 2348–2157 B.P.) at the Vinette site and was certainly commonly used by 1500 B.P. in this region. The phytolith record indicates a more-or-less continuous presence for maize in the region, with

all dates but the earliest from Vinette falling within the range of direct dates for maize macrobotanical remains from the riverine interior (Hart et al. 2007b). The early date from Vinette suggests that the macrobotanical remains from Meadowcroft need to be seriously reconsidered as positive evidence for maize use in the Northeast at this time pending direct AMS dating. Interestingly, Brown's (2006a:656) glottochronological analysis indicates only that maize became a staple sometime after 3500 B.P.

Based on these results, it appears that maize and squash were being grown in the region much earlier than was thought previously. Phytoliths of both squash and maize have been found together in residues dating as early as 1525 ± 35 B.P. (cal. 2σ 1518–1345 B.P.) at the Fortin 2 site in the Upper Susquehanna River valley (Thompson et al. 2004). Bean, on the other hand, appears to have a shorter history in the Northeast than previously thought.

Phaseolus vulgaris

The macrobotanical evidence for bean in northeastern North America has changed significantly since the mid-1990s. A direct AMS date of 658 ± 48 B.P. (cal. 2σ 677–550 B.P.) on a bean cotyledon from Feature 35 at the Roundtop site in the Upper Susquehanna River valley in New York (Hart 1999b) contradicted the assertion by Ritchie (1969, Ritchie and Funk 1973) that bean was present at this site by the ninth century B.P. Ritchie's association of bean with a date on charcoal from another feature of 880 ± 60 B.P. (cal. 2σ 918–694 B.P.) was widely accepted in the archaeological and paleoethnobotanical literature, and the bean was often cited as the earliest occurrence in eastern North America (e.g., Riley et al. 1990; Yarnell 1976). My colleagues and I subsequently obtained direct AMS dates on an additional 35 bean remains from purportedly cal. pre-650 B.P. contexts at 24 sites across northeastern North America (Hart et al. 2002; Hart and Scarry 1999). While not every bean remain from such contexts was accessible for the project, there is currently no credible macrobotanical evidence for bean in northeastern North America prior to cal. 700–650 B.P. Brown's (2006b) glottochronological analysis is consistent with these results. While some may question the sole reliance on direct AMS dates to establish this history, given that so many direct dates on bean from purportedly pre-700 B.P. contexts were shown to be late, any purported pre-700 B.P. bean must be questioned in the absence of a direct date.

None of the residues from pottery analyzed to date have yielded the distinctive hook-shaped hairs characteristic of bean pods (see Bozarth 1990). The recovery of a single hooked hair from residue encrusted on the interior of a steatite vessel sherd dating to the cal. fourth millennium B.P. (Hart et al. 2008) is undoubtedly from an indigenous legume given that there is no evidence for

bean north of Mexico prior to 2500 B.P. (Kaplan and Lynch 1999).

Summary

It appears at this time that squash and maize have extended histories in the Northeast, while bean, and therefore, maize-bean-squash agriculture has a much shorter history. The maize-bean-squash remains from Feature 35 at Roundtop, with a pooled mean date of 667 ± 30 B.P. (cal. 2σ 674–559 B.P.) on maize, bean, and a twig, are the earliest occurrence of the three crops together in the Northeast (Hart 1999b). The previous correlations of the development of Iroquoian cultural traits in New York and southern Ontario with the adoption of these crops is no longer tenable; each of the crops and the various Iroquoian traits have separate histories, only merging together later in prehistory, sometime after cal. 700 B.P. (see Hart 2000b, 2001; Hart and Brumbach 2003, 2005; Hart and Means 2002). The crops did not have immediate transformative impacts on settlement and subsistence patterns (compare to Chapdelaine 1993). Rather, there appears to have been over a millennium of time during which two of the crops were in use before the advent of nucleated villages and longhouses with the inferred matrilineal residence pattern (Hart 2000b, 2001; Hart and Brumbach 2005; Hart and Means 2002). How do we explain, then, the adoption of these crops and their long-term use prior to the advent of the settlement and subsistence traits to which they have been traditionally linked?

MODELING CROP ADOPTIONS AND AGRICULTURAL EVOLUTION

We are presently not in a good position to understand the implications of the new chronological evidence for maize, bean, and squash. There is need to think about new ways of understanding the processes of maize, bean, and squash adoptions in new areas and the manners in which archaeological recovery techniques and archaeological site formation processes bias the recovery of evidence for these adoptions (Hart 1999c, 2001, 2003). As often happens in science, the discovery of new, unexpected evidence requires a change in methods for linking evidence with theory. This perspective suggests that there is need to have a larger incorporation of biological theory and fact into our efforts to understand the adoption and histories of these crops in various regions (Hart 1999c, 2003).

Three simple models can inform our perceptions of crop adoptions and histories and the meaning of early archaeological evidence. These are the biological, shifting balance, and archaeological recovery models. Each model builds on the others and has implications for understand-

ing crop adoptions and intensifications of production. In the following sections I discuss how these models can provide important insights on the adoptions and intensifications of these crops in the Northeast, and the kinds of evidence needed to track the early histories of maize, bean, and squash in the region.

Biological Model

The biological model (Cleveland et al. 2000; Falconer and Maekay 1996; Soleri and Cleveland 2004) is expressed by this very simple equation:

$$(1) V_P = V_G + V_E + V_{G \times E}$$

where:

- V_P is population phenotypic variation,
- V_G is population genotypic variation,
- V_E is environmental variation, and
- $V_{G \times E}$ is genotypic-environmental interaction.

Environmental variation can in turn be broken down into at least three components as expressed by this equation:

$$(2) V_E = V_L + V_T + V_M$$

where:

- V_L is variation in location including edaphic and climatic variation,
- V_T is variation in time including season, and
- V_M is variation in human crop management activities.

Each of these, of course, is affected by the interactions of human and crop populations. Variation in location results from the human-determined siting of agricultural fields, which includes the frequency of field movement to track that of human populations across the landscape (Hart 1999c, 2001). Because plants are sessile, they must be adapted to a specific location (Bradshaw 1972; Linhart and Grant 1996). For example, environmental conditions explain the diversity of maize varieties in non-industrial-agricultural areas of Mexico and Central America (Anderson 1947; Brush and Perales 2007). V_T is determined by human-mediated planting schedules. V_M is determined by human activities concerned with the manners in which crops are planted and tended. This latter is affected by V_L because management includes development of the agroecology in which crop plants are grown (Rindos 1984), thus necessitating the addition of an interaction term in the equation so that it becomes :

$$(3) V_E = V_L + V_T + V_M + V_{M \times L}$$

where:

- $V_{M \times L}$ is the interaction between location and management (see e.g., Gómez et al. 2000; Pressoir and Berthaud 2004a, 2004b; Soleri and Cleveland 2001, 2004; Smale et al. 2001).

While the model is quite simple, it has important implications for how crops would have responded to adoption

in new areas. In present day industrial agriculture, large expenditures of energy and resources are made to customize agricultural fields to specific crop varieties (McCann 2004). This represents a major departure from the long history of small scale agriculture in which crops were adapted to specific locations via selection acting on intrapopulation variation resulting in the many varieties evident in the ethnohistorical record and maintained traditional crops (e.g., Parker 1910; Russell 1980; Waugh 1916). The relationships between environment, population structure, and management on crop diversity are well established in traditional farming communities, for example, in Mexico (e.g., Longmire and Moldashev 1999; Soleri and Cleveland 2001).

In order to understand crop adaptations, it is necessary to understand the sources of variation on which selection could act. Founder populations represented the introductions of crops into new areas (see Hart 1999c). Variation in the first generation of a founder population, V_{G1} , was dependent on the variation in the parent population, the sample of that variation captured in the seeds entering the new area, and any subsampling done thereto by the adopting human population (Hart 1999c; also see Taylor and Keller 2007). This can be expressed by the following equation :

$$(4) V_{G1} = V_{GPar} - V_{GS1} - V_{GS2}$$

where:

- V_{G1} is the variation in the first generation of the founder population,
- V_{GPar} is the variation in the parent population,
- V_{GS1} is the variation not in the sample of the parent population, and
- V_{GS2} is the variation removed by any subsequent subsampling.

The genetic variation in the founder population would determine in part its ability to survive in and become adapted to its new environment through selection (Hart 1999c).

Subsequent variation in the founder population would be determined by environmental and genetic variation as expressed in the original equation:

$$(1) V_P = V_G + V_E + V_{G \times E}$$

in which V_E includes the term V_M , which in turn includes human activities that would have affected genetic variation, including sampling, selection biases, and inclusion of seed from other populations obtained by trade in subsequent plantings, among others.

Also important to include in our understandings of the processes involved in establishing new crop populations is the concept of heritability (Cleveland et al. 2000; Falconer and Mackay 1996). Broad-sense heritability is that portion of phenotypic variation resulting from genetic variation: V_G/V_P . Narrow-sense heritability is the actu-

al proportion of phenotypic variation resulting from genotypic variation directly transmittable to the subsequent generation, or additive variation: V_A/V_P . Important for our purposes here is that not all phenotypic variation is heritable and thus subject to human mediated selection. So, for example, mass selection for productivity by choosing kernels from the best maize cobs in a given field in a given year may not produce more productive subsequent generations in different years in different fields, or even the same field under different climatic conditions (e.g., more or less rain).

Shifting Balance Theory Model

The second model is Sewall Wright's (1932, 1978a) shifting balance theory of evolution or SBT. An important component of which is the fitness landscape, represented here in its simplified two-dimensional form (Figure 7-1). Although a fitness landscape is actually n-dimensional, for conceptual purposes it can be simplified as a topographic map with the contour lines representing fitness values for the alleles of two genes or the expressions of two phenotypic traits on the X and Y axes. The peaks represent fitness optima and the valleys low fitness states. Given sufficient genetic variation, selection will always push a population up the nearest fitness peak regardless of whether there are higher peaks on the fitness landscape. Given that selection will then act to maintain a population on its peak, the primary issue in adaptive evolution is how a population can move to and ascend a higher fitness peak (Wright 1978a).

While SBT was designed and is still used as a general model of evolution (e.g., Nicklas 1997; Wade and Goodnight 1998), it was devised by Wright based on his

knowledge and experience with agriculture (Provine 1986; Wright 1978b). As a result, it should have general applicability in modeling prehistoric agricultural evolution (Hart 1999c). Under SBT, a population is split into numerous subpopulations, or demes, partially isolated from gene flow, and scattered across the fitness (and physical) landscape. Three forces interact in the adaptive evolution process: selection, drift (or chance), and gene flow as affected by population structure and migration. While each of these forces may hold sway at a given time, the three balance out in population adaptive evolution. SBT occurs in three phases. In Phase I, demes move across the fitness landscape as a result of genetic drift—the stochastic part of the process. In Phase II, one or more demes approach fitness peaks and ascend them as a result of selection working on genetic variation. In Phase III migrants from the more fit demes, those on higher fitness peaks, pass favorable gene complexes to less fit demes, allowing them to ascend higher fitness peaks, thus increasing the fitness of the whole population.

Maize, is a monoecious plant, producing both staminate (male) and pistillate (female) flowers. The male flower, the tassel, is located at the top of the plant, while the female flowers are located further down the stalk. This arrangement minimizes self-fertilization (selfing). Fertilization is anemophilous (achieved by the movement of pollen by wind). In theory, each kernel on a maize ear may have a different male parent. *Cucurbita pepo* is also a monoecious plant, but it is entomophilous (insect pollinated), most commonly by solitary bees of the genera *Peponapis* and *Xenoglossa* (Hurd et al. 1971). Each flower is open a single day, and insects are attracted to both male and female flowers by nectar. The production of male and female flowers is determined by levels of female hormones in the plant, and this in turn is affected by various factors including temperature, moisture availability, stress, age of plant, photoperiod, maturing fruits on the plant, and inbreeding depression (Avala-Shkar et al. 2001; Hayes et al. 2005a; Jóhannsson and Stepenson 1998; Robinson and Decker-Walters 1996). The production of flowers on any given plant is timed to minimize selfing (Robinson and Decker-Walters 1996). In the absence of pollination, fruits may develop parthenocarpically (without fertilization) late in the season when temperatures are lower and day lengths are shorter (Robinson and Decker-Walters 1996:19).

Both *Zea mays* and *Cucurbita pepo* are subject to inbreeding depression in small populations in the absence of gene flow through repeated mating in a population of close relatives. Inbreeding has a variety of deleterious effects that lower fitness in these species (e.g., Hallauer and Miranda 1988; Hayes et al. 2004a, 2004b, 2005a, 2005b; Jóhannsson et al. 1998; Jugenheimer 1976). As a result, prior to their becoming major crops, the popula-

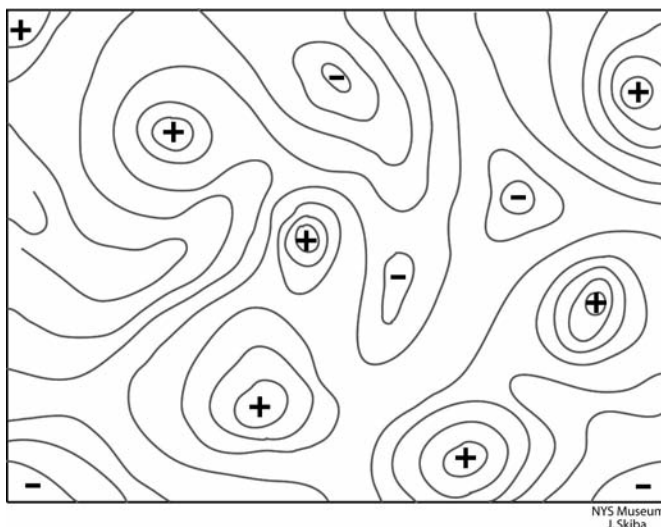


Figure 7-1 Simplified two-dimensional fitness landscape (after Sewall Wright 1932)

tion structure most feasible for a maize or cucurbit population's long-term survival was that envisioned by Wright in SBT (see details in Hart 1999c).

By returning to the biological model we can see how a population structure as in SBT, created through cucurbit and maize dispersal within dispersed human populations, would affect genetic variation. Drift and sampling would increase the amount of genetic variation (V_G) within the population as a whole even while limiting it within a given deme. Environmental variation (V_E) would increase for the population as a whole through dispersal across the physical landscape (V_L) as well as through varied management (V_M) practices by components of the dispersed human population and the interaction between location and management (V_{MXL}). These would both serve to locate crop demes on the fitness landscape and, if fields remained in place for long enough, would allow a deme or demes to ascend fitness peaks given enough genetic variation. Changes in the physical environment such as in field locations or management practices, and changes in genetic structure caused by samplings of seed for subsequent years' crops, gene flow between populations, and random climatic events, among other variables could relocate a deme onto another fitness peak, either higher or lower. Such variables could also result in an entirely new fitness landscape.

Exchange of seed stock among components of the dispersed human population (seed flow; e.g., Pressoir and Berthaud 2004a; Rice et al. 1997) would affect gene flow within the crop population, potentially increasing genetic variation (V_G) within demes and populations. Cross pollination between demes and even populations in cucurbits is very feasible because insects can and do travel relatively long distances. Cross pollination between maize demes is less likely and probably extremely rare between populations because maize pollen does not generally disperse more than a few hundred meters beyond the edges of maize fields (e.g., Bannert and Stamp 2007; Goggi et al. 2006; Luna et al. 2001). Different timing of anthesis in maize populations will also isolate those varieties from gene flow with one another (Pressoir and Berthaud 2004b). We would also expect a large amount of phenotypic variation in the population resulting from genetic and environmental interaction (V_{GxE}), only a small portion of it being heritable in the narrow sense. However, because of frequent settlement and, therefore, agricultural field movement, some crop demes may never have ascended fitness peaks, but, rather, were kept in constant motion on the fitness landscape as in the Red Queen hypothesis (Van Valen 1973).

Phaseolus vulgaris has hermaphroditic flowers, containing both stamens and pistelles, and is largely selfing; any cross pollination is entomophilous. The outcrossing rate for this species is 5% or less (e.g., Ferreira et al. 2000, 2007;

Ibarra-Pérez et al. 1996, 1997). Because it is selfing and does not suffer inbreeding depression in the absence of gene flow, once it had become adapted to broad environmental conditions, such as photoperiod and temperature (Massaya and White 1991) it could have spread fairly rapidly. The need for a population structure to ensure genetic variation as in SBT was not important for early adoption and dispersal of this crop as it was for maize and cucurbits. However, its dispersal across varying environments would result in the evolution of varieties.

We can see, then, that the adaptive evolution of maize and squash adopted into a new region was affected to a large degree by the structure of the adopting human population, including its internal dispersal and frequency of movement across the physical landscape, as well as the interaction between components of dispersed populations (Hart 1999c, 2001). As a result, we should not expect any simple linear trend in the evolution of agricultural systems in any given region. Rather we should envision a series of fits and starts, some leading to dead ends and extinctions of founder populations, and others to short- or relatively long-lived peaks in crop reliance prior to the widespread phenomenon of agricultural dependency throughout those regions (cf. Hart 1999c; Rindos 1984).

Archaeological Recovery Model

The third model is the archaeological recovery model, which connects the biological and shifting balance models to what we find in the archaeological record (e.g., Lopinot 1992:55-59; Miksicek 1987). I will use macrobotanical remains as an example because they have been used most frequently to address issues of crop adoptions, at least in eastern North America.

The probability of identification (P_I) of crop remains at a site can be represented by this equation:

$$(5) P_I = P_A \times P_R$$

where:

P_A is the probability of a crop entering the archaeological record, and

P_R is the probability of probability of crop remains being recovered at a site on which it is preserved.

P_A is captured in this equation:

$$(6) P_A = P_S \times P_C \times P_{SxC} \times P_D$$

where:

P_S is the effect of site use, which is expressed in this equation:

$$(7) P_S = S_I + S_L + S_F$$

where:

S_I is the intensity of site use,

S_L is the length of site use, and

S_F is the frequency of site use.

Each of these reflects the amount of time spent on a particular location and the number of cooking events that occur at that location. The greater the number of cooking episodes, the greater the probability that crops will be lost and deposited in a context that ensures their preservation. For example a site that is occupied on a seasonal basis (S_L) repeatedly over a period of many years (S_F) by a relatively large number of people (S_I) provides a greater probability of crop remains entering the archaeological record than does a site occupied only a few times (S_F) during the same season (S_L) by a smaller number of people (S_I).

P_C is the effect of a crop's use, which is expressed in the equation:

$$(8) P_C = C_C + C_I + C_L + C_S$$

Where

C_C is manner(s) in which the crop was cooked at a site,

C_I is the intensity of the crop's use at the site during any given occupation,

C_L is the length of the crop's use in any given occupation, and

C_S is the kind of facilities in which maize was stored between harvesting and consumption.

The interaction of site use and crop use, P_{SXC} , determine the probability that the crop will be lost and charred and/or charred and purposefully discarded.

P_D is the probability of the deposition of charred crop parts in a context favorable for preservation.

This depends on the crop parts being processed and their exposure to heat for charring or conditions that facilitate desiccation or deposition in moist anaerobic conditions (e.g., Goette et al. 1994; King 1987; van der Veen 2007; Wright 2003).

King (1987:146–149) found that dried, flint maize kernels were more likely to preserve during charring than were fresh, moist kernels, which tend to pop and distort (also see Wright 2003). In fact, King (1987:147) suggests that many of the kernels found in the archaeological record were flint kernels processed as hominy, resulting in the crescent shape typical of especially later archaeological sites. "Given the difficulty of carbonizing maize kernels without distortion, it appears likely that many of the whole, well-preserved, maize kernels that occur in archaeological sites represent maize that had been boiled or made into hominy. More fragmentary remains may represent that carbonized during parching or roasting." Goette et al. (1994:8) reported similar results, "the mote [hominy] kernels were the quickest to char and were the most durable after charring, thereby making them the strongest candidates for preservation. In addition, they show the closest resemblance to much archaeological maize in lacking their pericaps, often their points of

attachment, and occasionally their embryos." Myers (2006) suggests that hominy technology was adopted relatively late across eastern North America. Wright (2003:582) found that preservation is more likely at lower temperatures and shorter exposure times in reducing atmospheres and when specimens are moist (also see Goette et al. 1994:12).

Cucurbit use was a major determining factor in its entering the archaeological record. For example, if Mid-Holocene gourds were used primarily as fish net floats, it seems unlikely that they would be exposed to fire frequently enough to enter and preserve in the archaeological record. A higher probability for entering the archaeological record would obtain if heat was used to process gourd seeds and/or flesh for consumption (Hart 2004; Hart et al. 2004). However, even in some cases where squash use was documented on ethnohistorically recorded sites, macrobotanical remains are very rare (Hart and Asch Sidell 1997:530).

To my knowledge, experiments similar to those done with maize kernels have not been performed for bean seeds. However, it has been my experience that bean cotyledons do preserve well, including seemingly fragile diagnostic structures such as the plumule and hilum (Hart et al. 2002). It seems likely that short exposure time in a reducing atmosphere would increase the probability of bean being charred and entering the archaeological record.

At late prehistoric village sites where it can be reasonably inferred that crops were used year-round by large numbers of people only fragmentary remains are typically found, except where subterranean storage facilities were burned or maize cobs were used as fuel in smudge pits. However, with maize, the remains tend to be more ubiquitous than at earlier, seasonally occupied, sites. If Myers (2006) is correct that hominy technology was a relatively late development in eastern North America, it might in part explain this pattern (C_C).

The probability of crop remains being recovered at a site, on which it is preserved, P_R , is captured in this equation:

$$(9) P_R = E_S + T + L_S + I$$

where:

E_S is excavation sampling relative to the frequency and distribution of maize on the site,

T is the recovery technique used (such as flotation),

L_S is the sampling intensity in the lab, and

I is the identification effort in the lab.

As should be evident, the greater the effort expended on each of these variables, the greater the probability that rare macrobotanical remains will be found. For example, the earliest, directly dated maize macrobotanical remains in eastern North America are from the Holding site (Riley

et al. 1994), with a pooled mean of 2037±41 B.P. (cal. 2σ 2115–1898 B.P.) on directly AMS-dates maize remains. A total of 5,340 liters of soil were processed at this site yielding only 19 pieces of charred maize. A less intensive sampling and identification effort may very well have missed these early remains. However, at a site where S_V , S_L , and S_F were all high and cooking methods favored preservation, less intensive sampling and identification efforts will probably result in maize recovery and identification. This model can be modified to reflect any physical line of evidence for crops such as phytolith assemblages in charred cooking residues. The major categories do not change, but the specific elements will.

CONCLUSION

The adoption and perpetuation of agricultural crops in new locations is not always a simple proposition, nor is the recovery and identification of crop remains. What should be clear from the preceding discussion is that numerous interacting biological and cultural variables influence the success of a crop's adoption and perpetuation as well as its preservation and discovery in the archaeological record. In essence, the recovery and identification of crop remains from the archaeological record is the terminal point of a long probability tree. Each such probability tree encompasses numerous nodes including: (1) the actions of prehistoric individuals and their decisions regarding the management of those crops, (2) the nature of prehistoric settlement patterns, (3) the nature of prehistoric storage and cooking processes, and (4) the decisions of archaeologists and paleoethnobotanists regarding sampling and processing both in the field and laboratory. Each probability tree connects the actions of modern archaeologists and paleoethnobotanists with those of ancient farmers. Each of the various steps on a probability tree must be carefully considered and modeled. Doing so will allow us to better understand the meanings of the crop remains we find on archaeological sites.

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CHAPTER 8

CULTIGENS OF THE AMERICAN NORTHEAST: A PHYTOLITH STUDY

by Katy Serpa

Researchers during the 1970s became widely aware that phytoliths with taxonomic significance are produced in large numbers by many different types of plants. Moreover, it was found that phytoliths exhibit remarkable durability in soils and sediments over very long periods of time, therefore creating an increasingly popular study. Phytolith research in North American archaeology began to grow extensively during the late 1980s and 1990s, most notably from the work of Steven Bozarth and Susan Mulholland. Their research was mainly centered upon grass and *Curubita* phytoliths. However, many other plants exploited during prehistory, and especially ones native to the Northeast, remained unexplored.

The aims of this research are to create a phytolith reference collection for commonly utilized plants in Northeast American prehistory. Twenty-one species were selected for this study and the presence or absence of morphologically distinct phytoliths was determined. Two systematic approaches were applied during analysis; a botanical approach in which articulated phytoliths were examined for distinct features and a morphological approach, which relied on the shape of disarticulated phytoliths. The results of this comparative collection have illustrated that there is great potential for phytolith research on plants indigenous to the American Northeast.

Phytoliths, literally meaning “plant-rocks,” are opaline silica bodies formed in epidermal and other plant cells due to the uptake of monosilicic acid in the ground water (Pearsall 2000:356) and often consist of complete sections of silicified epidermal tissue in the form of articulated cells. Because phytoliths are mineral, they resist decomposition, and are usually deposited in situ. Transport, for example by wind, of phytoliths is rare and they are usually found in situ because the opaline silica bodies are deposited where the plant has decayed. In addition, vertical phytolith movement within the soil has been found to not cause unique or distinctive problems in phytolith

study (Piperno 2006:111). Phytoliths do not rely on carbonization to be preserved and may reveal plants that would otherwise remain invisible in the archaeological record. These factors make phytoliths a useful diagnostic tool used in archaeological analysis. Their remarkable preservation enhances the recovery of data and interpretation of sites that are, for example, inimical to pollen, and makes their study in conjunction with plant macroremains invaluable (Dincauze 2000:363).

However, the presence or absence of morphologically distinct phytoliths in many plants indigenous to North America is not yet known. In addition, phytolith systematics and taxonomy are not universal and a standard classification still needs to be accepted. In an effort to standardize the nomenclature used to describe and record phytoliths an International Code for Phytolith Nomenclature (ICPN) was developed by the Society for Phytolith Research (SPR) in conjunction with the International Working Group on Phytolith Nomenclature (IWGPN) (Madella et al. 2005:253).

In the current study, phytoliths produced in the fruit, inflorescence bracts, leaves and stems of 21 plants from northeastern North America are examined. When possible the edible part of the plant was selected for sampling. This was done for two reasons. First, this section of plant will most likely turn up in the archaeological record. Second, Piperno (2006:19) has noted that a higher phytolith content may occur in fruits and other structures containing seeds rather than in the leaves and stems of silicon-accumulating plant species. This is true for many cultivated cereals. Therefore, six specimens from the Poaceae family and one from the Brassicaceae family were separated into inflorescence and a combination of leaves, stems and awns for the purpose of inferring crop processing procedures. The 21 species used in this study were maize (*Zea mays* ssp. *mays*), Virginia wild rye (*Elymus virginicus*), Canada wild rye (*E. canadensis*),

Table 8-1. Sources of plant specimens from the Rochester Academy of Science Herbarium

Current Taxonomy	Herbarium Sheet Species Listing, Plant Part Sampled, and Source of Sample
<i>Zea mays</i> ssp. <i>mays</i>	<i>Zea mays</i> – inflorescence (no source listed)
<i>Zea mays</i> ssp. <i>mays</i>	<i>Zea mays</i> – inflorescence (no source listed)
<i>Zea mays</i> ssp. <i>mays</i>	<i>Zea mays</i> – inflorescence (no source listed)
<i>Zea mays</i> ssp. <i>mays</i>	<i>Zea mays</i> – inflorescence (no source listed)
<i>Elymus virginicus</i>	<i>Elymus virginicus</i> L. – inflorescence, Border of Mud Creek, Newark, N.Y. 9/16/1871 E.L. Hankenson
<i>Elymus virginicus</i>	<i>Elymus virginicus</i> – leaf, stem
<i>Elymus canadensis</i>	<i>Elymus canadensis</i> L. var. <i>glaucofolius</i> – leaf, stem, inflorescence, Point Pleasant, NY Foot of hill 8/7/1941, DW White
<i>Phalaris caroliniana</i>	<i>Phalaris caroliniana</i> Walt. – leaf, stem, 6/23/1950 Ralph W. Kelting Common along dewatered shoreline of Mallard Cove, Salt Plains Lake, Alfalfa Co. Oklahoma
<i>Phalaris caroliniana</i>	<i>Phalaris caroliniana</i> – inflorescence
<i>Hordeum pusillum</i>	<i>Hordeum pusillum</i> Nutt. – leaf, stem, Peoria, Il. Dry sandy soil, F.E. McDonald June 1903
<i>Hordeum pusillum</i>	<i>Hordeum pusillum</i> – inflorescence,
<i>Zizania palustris</i>	<i>Zizania palustris</i> L. – inflorescence, Tuckahoe, N.J. 8/24/1916 E.P. Killip
<i>Zizania palustris</i>	<i>Zizania palustris</i> – leaf, stem, awn
<i>Zizania aquatica</i>	<i>Zizania aquatica</i> L. – leaf, stem, inflorescence, Genesee River, Monroe Co. July 1877 M.S. Baxter
<i>Elymus repens</i>	<i>Agropyron repens</i> – inflorescence
<i>Elymus caninum</i>	<i>Agropyron caninum</i> Beauv. – leaf, stem, inflorescence, Bergen, NY 8/18/1918 M.S. Baxter
<i>Lepidium densiflorum</i>	<i>Lepidium densiflorum</i> (L. <i>apetalum</i> Willds) – stem, inflorescence, H.R. Goodwin Mendon Ponds, Monroe Co. NY 7/12/1941
<i>Lepidium densiflorum</i>	<i>Lepidium densiflorum</i> – seeds
<i>Lepidium virginicum</i>	<i>Lepidium virginicum</i> L. – leaf, stem, inflorescence, June 30 1906 Dry sandy field Rochester, NY, V. Dewing
<i>Lagenaria siceraria</i>	<i>C. Lagenaria vulgaris</i> – leaf, flower (petal) “Dipper Gourd” Aug 1928 Stay, KY garden A.B. Suydam
<i>Cucurbita foetidissima</i>	<i>Cucurbita foetidissima</i> H.B.K. – leaf, flower (whole) (C. pepo not available) “Pumpkin” Aug 1917 Florence Beckwith, Trinidad, CO (also wild pumpkin 1912)
<i>Strophostyles helvula</i>	<i>Phaseolus diversifolius</i> Pers. (<i>Strophostylus angulosa</i> Ell.) – leaf, stem, inflorescence (<i>P. vulgaris</i> not available) Sand Bar, Irondequoit Bay NY 8/29/1869 George T. Fish
<i>Phaseolus polystachios</i>	<i>Phaseolus polystachios</i> BSP. – leaf, stem, inflorescence, Sodus Bay, NY August 1867 E.L. Hankenson
<i>Nicotiana rustica</i>	<i>Nicotiana rustica</i> L. – leaf, stem, flower Hudson Ave dumping ground waste field, Rochester, NY 10/5/1920 D.M. White
<i>Polygonum erectum</i>	<i>Polygonum erectum</i> L. Roth; var – leaf, stem, inflorescence, J.B. Fuller collected “door-yard, with ariculare 1865
<i>Chenopodium berlandieri</i>	<i>Chenopodium berlandieri</i> Nutt. – leaf, stem, inflorescence, Kansas City, MO 8/3/1926 “watte ground” B.F. Bush Smithsonian Institute US National Herbarium
<i>Helianthus maximiliani</i>	<i>Helianthus maximiliani</i> Schrad. – Seeds (no source listed)
<i>Iva annua</i>	<i>Iva annua</i> L. – Seeds, Mississippi County, Missouri Collected November 1985
<i>Cururbita pepo</i> ssp. <i>ovifera</i> var. <i>ozarkana</i>	<i>Cururbita pepo</i> ssp. <i>ovifera</i> var. <i>ozarkana</i> – Rind Southwest Missouri Collected in 2000
<i>Phaseolus vulgaris</i>	<i>Phaseolus vulgaris</i> – seeds and pod, Local garden in Rochester, NY

maygrass (*Phalaris caroliniana*), little barley (*Hordeum pusillum*), annual wild rice (*Zizania aquatica*), northern wild rice (*Z. palustris*), wheatgrass (*E. caninum*), common pepperweed (*Lepidium densiflorum*), Virginia pepperweed (*L. virginicum*), buffalo gourd (*Cururbita foetidissima*), pumpkin (*C. pepo*), bottle gourd (*Lagenaria siceraria*), thick-et bean (*Phaseolus polystachios*), common bean (*P. vulgaris*), trailing wooly bean (*Strophostyles helvula*), marshelder (*Iva annua*), Maximilian sunflower (*Helianthus maximiliani*), tobacco (*Nicotiana rustica*), erect knotweed (*Polygonum erectum*), and goosefoot (*Chenopodium berlandieri*). These species were selected because of their historical, economical, agricultural and archaeological significance in the

Northeast (Crawford and Smith 2003; Hart 1999; Scarry 1993; Smith 1992).

MATERIALS AND METHODS

Reference material from dried plants indigenous to New York (Mitchell and Tucker 1997) was obtained by permission of the Rochester Academy of Science Herbarium, the New York State Museum, and the Smithsonian Institution (Table 8-1). Plant tissue from the leaf, stem, and inflorescence was extracted and separated into 29 samples, and incinerated at 500 °C in a Coneart BX-119 digital electric

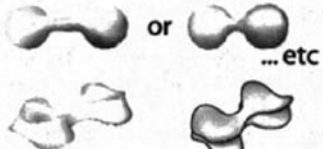












Schematic drawings*	ICPN names	Schematic drawings*	<i>Nomina conservanda</i>
	Bilobate short cell		Cross
	Trapeziform short cell		Dentritic
	Cylindrical polylobate		Papillae
	Elongate echinate long cell		Rondel
	Acicular hair cell		Saddle
	Unciform hair cell		
	Globular granulate		
	Globular echinate		

Figure 8-1. Common disarticulated phytolith types (Madella et al. 2005:253-260). Reprinted by permission of Oxford University Press.

kiln for 8 to 16 hours. The ashed material was then mounted on a microscope slide with Piccolyte and left for 4 weeks in a fume cupboard to dry. Optical microscopy was used at magnifications of 100x and 430x, and images of the extracted phytoliths were recorded using a Nikon CoolPix 900 digital camera. If phytoliths were present, phytolith types produced by each species were noted and described. In the absence of digital image analysis software, measurements were calculated with an eyepiece micrometer at magnification of 430x and are therefore imprecise. The results of each measurement had to be multiplied by a factor of 2.38 to equal their true μm measurement.

Each of the 30 slides was scanned a minimum of 10 times across to assess the variety of phytoliths present. All phytoliths of interest were recorded in a database and photographed. When a phytolith was identified as having distinctive characteristics it was assigned a name following the ICPN rules and coding. The shape and texture for each new phytolith was described using descriptors from the ICPN Glossary (Madella et al. 2005:253). To

ensure the utility of the glossary for the international community, terms with Latin or ancient Greek roots were used. It is important, in general, to note that caution should be used when assigning taxonomic significance to a phytolith type. If a phytolith is observed in a species but no other comparative studies are available, then the phytolith should be published as observed in that species and not as diagnostic of that species or higher-level taxonomic unit (Madella et al. 2005:253).

In addition to new phytolith types, commonly occurring disarticulated phytolith types were recorded for each slide (Figure 8-1). This frequency, derived from counting both new and common disarticulated phytolith types, is also referred to as a phytolith assemblage. Phytolith assemblages are used to infer plant taxa in a morphological approach to phytolith systematics. As well as individual opaline silica bodies, or disarticulated phytoliths, articulated phytoliths were recorded for each slide. Articulated phytoliths, also known as silica skeletons, retain a combination of characteristic cells, which can be used in the biological approach to identify particular plant taxa.

RESULTS

Twenty-one species from 10 plant families were analyzed on 29 slides. Below is a list containing their species and family Latin names and common names are presented in Table 8-2. Listed in Table 8-3 is whether the inflorescence was separated from the leaf and stem to infer plant processing. All plants from the Poaceae family were selected to be separated into a minimum of two slides due to the grass family's tendency to produce distinctive phytoliths.

As expected, all plants examined from the Poaceae family produced phytolith assemblages of known phytoliths types. In addition, some of these plants produced articulated phytoliths. As stated earlier, both classification systems may be used to interpret plant taxa. Phytoliths produced by *Zea mays* have been researched for many years, and extensive literature has been produced on the topic (Pearsall 2003; Piperno 2006). Insomuch, there is little need to recount this information in this chapter. The current research has reaffirmed the presence of the distinctive and diagnostic cross and rondel phytoliths (Figure 8-2). Recent phytolith research has found evidence of maize in New York as early as ca. 2270 B.P. (Hart et al. 2003, 2007; Thompson et al. 2004).

Interestingly, *Elymus* spp. exhibited distinct articulated dendritic phytoliths normally diagnostic to *Triticum* spp., wheat, an Old World crop (Figure 8-3, Ball 1993, 1996, 2001; Rosen 1992). *Triticum* spp. is unique in that measurements of the articulated dendritic phytoliths, found in fossilized sections of epidermal tissue, can be taken to

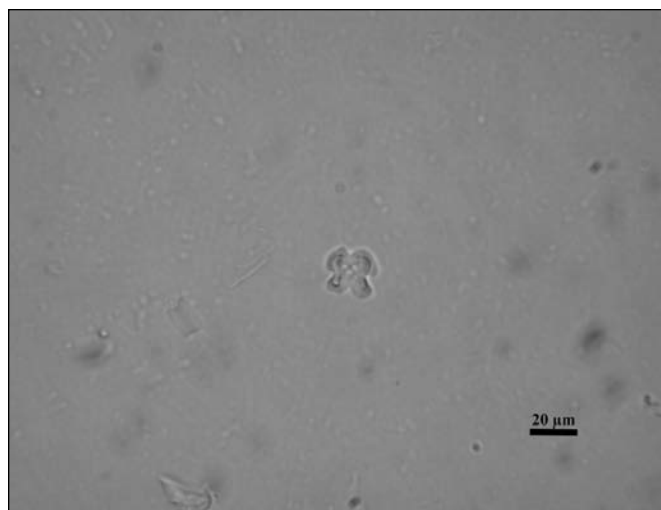


Figure 8-2. *Zea mays* ssp. *mays* inflorescence cross shape phytolith.

infer a specific species, a level of precision not usually observed in phytolith research. This patterning is commonly seen in *Hordeum* spp. as well. However, *Hordeum pusillum*, little barley, examined in the current study did not display the usual articulated dendritic phytoliths known to be present in Old World barley (Figure 8-4) (but see Hart et al. 2008).

Further research is needed for *Zizania* spp., wild rice. *Oryza sativa*, rice, indigenous to the Old World, exhibits a distinctive “double-peaked cell” (Zhang and Wang 1998; Zhao 1998). *Oryza* and *Zizania* are classified in the same

Table 8-2. Species and Family names of plants examined.

Species	Common Name	Family	Common Name
<i>Zea mays</i> ssp. <i>mays</i>	maize	Poaceae	grass
<i>Elymus virginicus</i>	Virginia wild rye	Poaceae	grass
<i>Elymus canadensis</i>	Canada wild rye	Poaceae	grass
<i>Phalaris caroliniana</i>	maygrass	Poaceae	grass
<i>Hordeum pusillum</i>	little barley	Poaceae	grass
<i>Zizania aquatica</i>	annual wildrice	Poaceae	grass
<i>Zizania. palustris</i>	northern wildrice	Poaceae	grass
<i>Elymus caninum</i>	wheatgrass	Poaceae	grass
<i>Lepidium densiflorum</i>	common pepperweed	Brassicaceae	mustard
<i>Lepidium virginicum</i>	Virginia pepperweed	Brassicaceae	mustard
<i>Cucurbita pepo</i>	pumpkin	Cucurbitaceae	gourd
<i>Cucurbita foetidissima</i>	buffalo gourd	Cucurbitaceae	gourd
<i>Lagenaria siceraria</i>	bottle gourd	Cucurbitaceae	gourd
<i>Phaseolus vulgaris</i>	common bean	Fabaceae	bean
<i>Phaseolus polystachios</i>	thicket bean	Fabaceae	bean
<i>Strophostyles helvula</i>	trailing wooly bean	Fabaceae	bean
<i>Helianthus maximiliani</i>	Maximilian sunflower	Asteraceae	aster
<i>Iva annua</i>	annual marshelder	Asteraceae	aster
<i>Nicotiana rustica</i>	tobacco	Solanaceae	nightshade
<i>Polygonum erectum</i>	erect knotweed	Polygonaceae	buckwheat
<i>Chenopodium berlandieri</i>	goosefoot	Chenopodiaceae	goosefoot

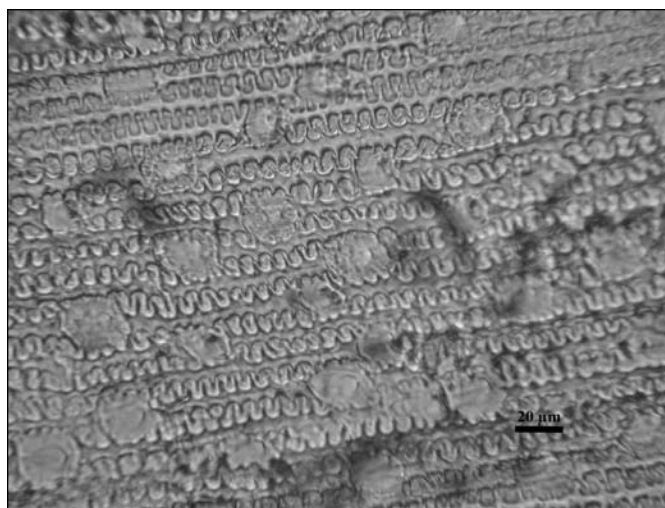


Figure 8-3. Articulated dendriform phytoliths – *Elymus repens* inflorescence (not part of the study).

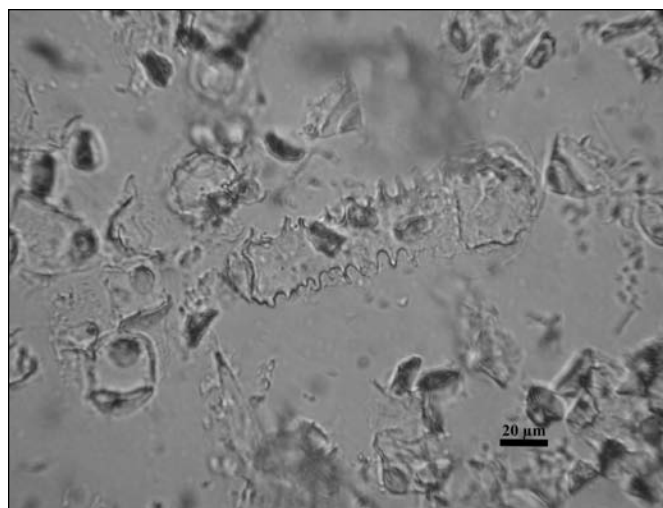


Figure 8-4. Phytoliths from a leaf of *Hordeum pusillum*.

subfamily, Oryzoideae, but belong to different tribes, Oryzeae and Zizanieae, respectively. This diagnostic phytolith may have been observed in the *Zizania* spp. samples examined in the current study. However, this cannot be confirmed due the limitations of optical microscopy. The few examples of what is thought to be the double-peaked cell encountered in the *Zizania* spp. samples are difficult to interpret within a two dimensional field. This would be resolved using a scanning electron microscope, a method beyond the scope of this research.

Lastly, *Phalaris caroliniana* (Figure 8-5) possessed a phy-

tolith assemblage containing many of the disarticulated phytolith types listed in Figure 8-1. Further research is required to determine if the types noted within *Phalaris caroliniana* are indicative to this plant taxon.

Few samples exhibited different phytolith assemblages for each plant part studied. Most notably are *Elymus* spp. (Figure 8-6). Only the inflorescence of each of the species examined displayed the distinctive articulated dendritic phytoliths. This patterning was lacking in the leaf epidermal samples. Moreover, the inflorescence of *Elymus* spp. can be separated into glumes, lemmas, and paleas to infer

Table 8-3. Number of slides examined for each species.

Species	Number of Slides
<i>Zea mays</i>	Leaf, stem, seeds, and inflorescence all separated – 4 slides
<i>Elymus virginicus</i>	Inflorescence separated from leaf and stem – 2 slides
<i>Elymus canadensis</i>	Not separated – 1 slide
<i>Phalaris caroliniana</i>	Inflorescence separated from leaf and stem – 2 slides
<i>Hordeum pusillum</i>	Inflorescence separated from leaf and stem – 2 slides
<i>Zizania aquatica</i>	Not separated – 1 slide
<i>Zizania palustris</i>	Inflorescence separated from leaf and stem – 2 slides
<i>Elymus caninum</i>	Not separated – 1 slide
<i>Lepidium densiflorum</i>	Seeds separated from inflorescence and stem – 2 slides
<i>Lepidium virginicum</i>	Not separated – 1 slide
<i>Cucurbita pepo</i>	Not separated – 1 slide
<i>Cucurbita foetidissima</i>	Not separated – 1 slide
<i>Lagenaria siceraria</i>	Not separated – 1 slide
<i>Phaseolus vulgaris</i>	Not separated – 1 slide
<i>Phaseolus polystachios</i>	Not separated – 1 slide
<i>Strophostyles helvula</i>	Not separated – 1 slide
<i>Helianthus maximiliani</i>	Seeds only – 1 slide
<i>Iva annua</i>	Seeds only – 1 slide
<i>Nicotiana rustica</i>	Not separated – 1 slide
<i>Polygonum erectum</i>	Not separated – 1 slide
<i>Chenopodium berlandieri</i>	Not separated – 1 slide

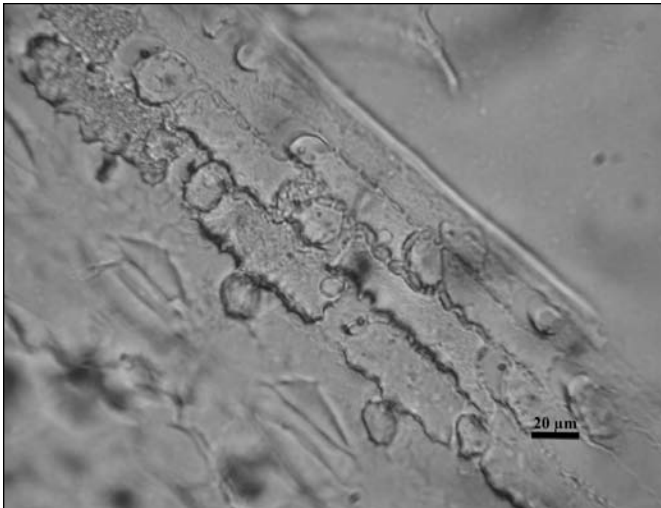


Figure 8-5. Phytoliths from a leaf of *Phalaris caroliniana*.

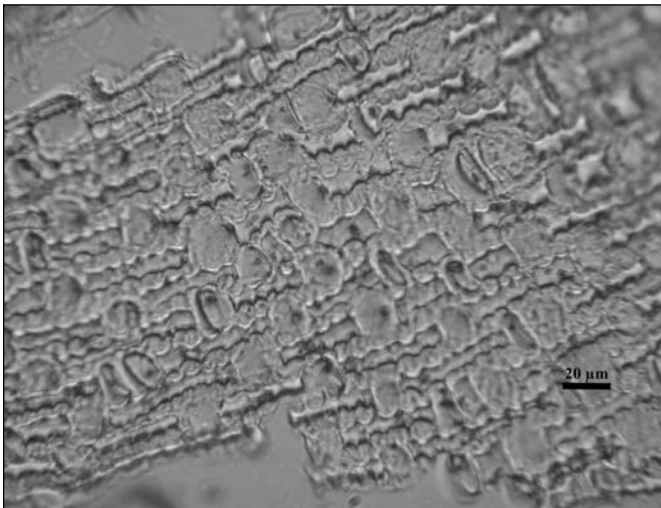


Figure 8-6. Phytoliths from an inflorescence of *Elymus virginicus*.

crop processing practices in future research (Figure 8-7).

In addition, it appears that the leaf and stem of *Zizania palustris* exhibited bilobate short cells in articulated epidermal segments and not in the inflorescence samples (Figure 8-8). Leaf epidermal tissue is easily identified when silicified stomata are present. Moreover, this patterning was not observed for *Z. aquatica*.

The remaining plants, apart from the Poaceae family, exhibited varying degrees of potential for future phytolith research (Table 8-3). All slides possessed silica bodies, or phytoliths, either fragmented or whole. Some contained redundant examples of new phytolith types and others contained undistinguishable irregular phytoliths. Asymmetrical irregular phytolith types can not be applied to a phytolith assemblage in order to identify

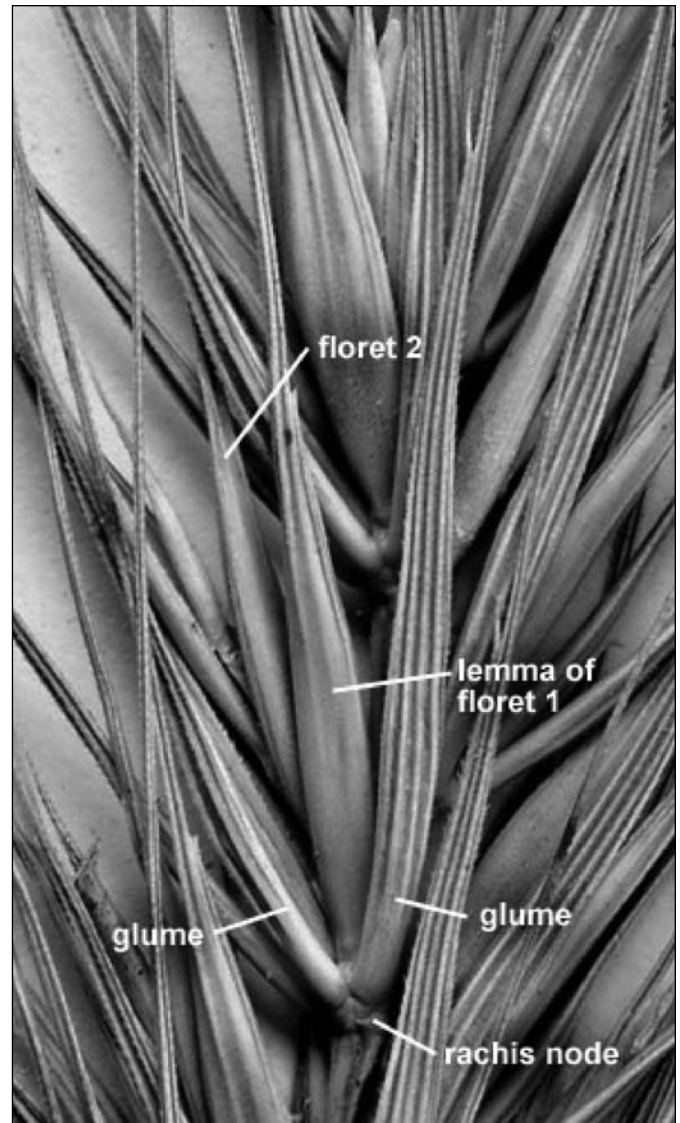


Figure 8-7. *Elymus glabriflorus* (Vasey ex L. H. Dewey) Scribn. & C. R. Ball Section of inflorescence. Photo (from herbarium specimen): Anna Gardner, Iowa State University.

specific plant taxa (Figure 8-9). Samples mainly containing these irregular types as well as a few disarticulated long cell types are considered to have low potential for phytolith research. Other samples possessed redundant new phytolith types described using the ICPN Glossary and may have potential for future phytolith research. In addition to the new phytolith types, irregular phytoliths were present as well, which may or may not affect their research potential.

Finally, two families exhibited many of the disarticulated phytolith types shown on Figure 8-1 and have been the subject of previous phytolith research (Bozarth 1986). These families are the gourd and bean, which comprise two-thirds of the maize-bean-squash agricultural triad of North America. Their research potential is obviously

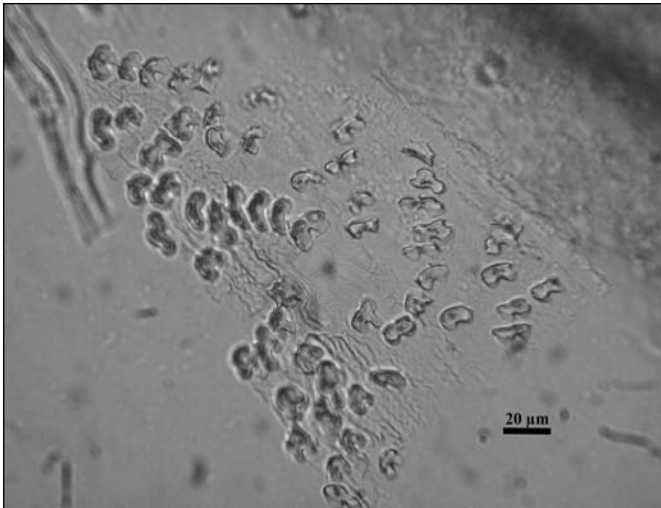


Figure 8-8. Phytoliths from a leaf of *Zizania palustris*.

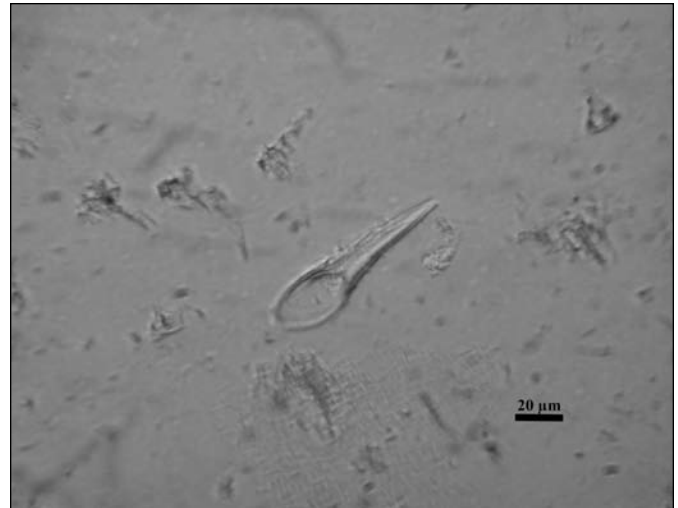


Figure 8-10. Phytoliths from a pod of *Phaseolus polystachios*.

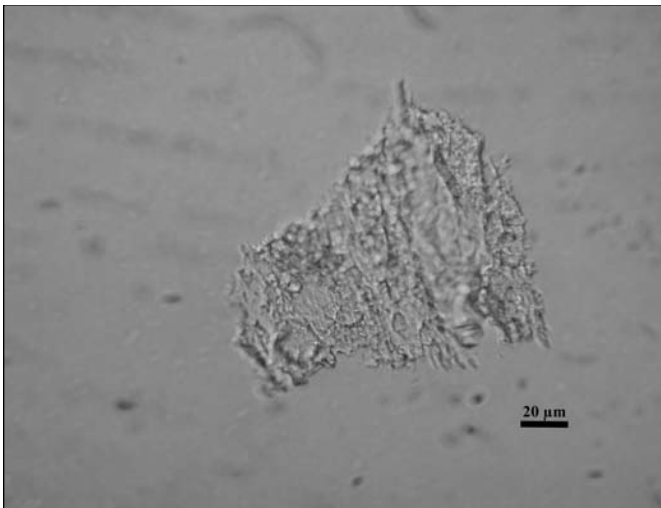


Figure 8-9. Irregular phytolith example from *Amaranthus graecizans* (not part of this study).

high. *Phaseolus* spp., bean, exhibited acicular hairs, which Bozarth (1986:58) noted as “distinctive hook-shaped silicified hairs” diagnostic to *Phaseolus* spp. (Figure 8-8). Interestingly however, the scalloped phytoliths Bozarth (1986, 1987) observed in the rind of *Cucurbita pepo* were not observed in the leaf or flower of *C. foetidissima* and *Lagenaria siceraria*. Regrettably, due to a processing error, the distinctive scalloped phytoliths were not observed in *C. pepo* as well. Recent phytolith research by Hart et al. (2007) evidenced the human exploitation of squash in New York as early as 2905±35 B.P. (cal. 2σ 1256–998 B.C.)

Research potential is implied by the level of phytolith production within a plant. The degree of phytolith development in a plant relates to a number of factors, including the climatic environment of growth, the nature of the

soil, the amount of water in the soil, the age of the plant, and, most important, the taxonomic affinity of the plant itself (Piperno 2006:5). It is clear that a great many angiosperms, gymnosperms, and spore-bearing plants, not just the Poaceae and few other monocotyledonous families, persistently silicify their vegetative and reproductive organs, leading to the production of high amounts of phytoliths with manifold shapes and surface decorations. A significant number of important crop plants make high amounts of phytoliths diagnostic at the genus or species level (Piperno 2006:17–18). It was a primary objective of this study to preliminarily identify which plants, documented as utilized in New York prehistory, are high phytolith producers. Each plant sample’s potential for future phytolith research is summarized in Table 8-4. Certain taxa are known to be high producers. As Piperno (2006:17-18) succinctly stated in her seminal work:

Solid deposits of silica can be found in measurable amounts in plants. However, the term “measurable” often includes nondescript fragments that have no value in plant identification. The term phytolith refers only to microscopically recognizable shapes, not amorphous pieces or traces of silica detectable only by microchemical methods that would not be recognized as discrete types . . . Hence, the plants can be characterized as silica-accumulating taxa, and they should be well represented in ancient phytolith assemblages, assuming they are stable in the depositional environment over time. Not every family that accumulates heavy amounts of phytoliths contributes a plethora of taxonomically significant forms, but many do so.

Table 8-4. Potential for future phytolith research of species examined in this study.

Species	Research Potential
<i>Zea mays</i>	High
<i>Elymus virginicus</i>	High
<i>Elymus canadensis</i>	High
<i>Phalaris caroliniana</i>	High
<i>Hordeum pusillum</i>	High
<i>Zizania aquatica</i>	High
<i>Zizania palustris</i>	High
<i>Elymus caninum</i>	High
<i>Lepidium densiflorum</i>	Moderate
<i>Lepidium virginicum</i>	Low
<i>Cucurbita pepo</i>	High
<i>Cucurbita foetidissima</i>	High
<i>Lagenaria siceraria</i>	High
<i>Phaseolus vulgaris</i>	High
<i>Phaseolus polystachios</i>	High
<i>Strophostyles helvula</i>	High
<i>Helianthus maximiliani</i>	Moderate
<i>Iva annua</i>	Moderate
<i>Nicotiana rustica</i>	Low
<i>Polygonum erectum</i>	Moderate
<i>Chenopodium berlandieri</i>	Low

Given the previous phytolith research on some of the plants selected for this study, it is known, for example, that *Zea mays* ssp. *mays* would be a high phytolith producer and therefore have significant research potential for New York prehistory, and, in contrast, that *Chenopodium berlandieri* would be a low producer and prove not to be visible in the phytolith record. However, some of the plants selected for this study have not yet been evaluated and published academically. Most notably, *Elymus* spp., although as members of the grass family are expected to produce an abundance of discrete and identifiable phytoliths, have proven to be very significant and will require future attention.

DISCUSSION

The phytolith comparative collection for cultigens found in New York prehistory has demonstrated that there is a great potential for phytolith research on plants indigenous to the American northeast. Morphologically distinct phytoliths were observed in all of the Poaceae samples, indicating the possibility of taxa identification through phytolith assemblage research. Moreover, silica skeletons were present in many of the Poaceae specimens, allowing a biological approach to infer taxonomy. In addition, *Cucurbita* (Figure 8-11) and *Phaseolus* resurfaced as genera with high phytolith potentials (Bozarth 1986; Piperno et al. 2000; Piperno et al. 2002) the current study documents possible new phytolith types within *Cucurbita* and the

likelihood of a phytolith assemblage for *Phaseolus*. The research potential of the nine plants remaining in this study range from moderate to low (Table 8-4); new phytolith types observed in these samples need to be confirmed before further research is conducted.

The original aim of this research was to establish a rudimentary phytolith comparative collection for future paleoethnobotanical studies at archaeological sites in the Northeast. The results show at least four areas where additional phytolith research can be focused: the enlargement of the existing comparative collection; the identification of phytolith assemblages present for each plant taxa; the identification of plants to a species level; and the identification of specific plant parts.

Additional plants need to be added to the reference collection to benefit Northeast paleoethnobotanical studies, as prehistoric plant-human relationships are complex. More specifically, additional plants from Cucurbitaceae, Fabaceae, Asteraceae, and Poaceae families ought to be sampled and examined due to their economic and historic importance. The Cucurbitaceae, Fabaceae, and Asteraceae families are significantly underrepresented in the phytolith record and the need for further paleoethnobotanical research is great. Plants from the Poaceae family have exhibited great potential for broadening phytolith systematics and must be further explored. Furthermore, grass plants have a tendency to produce distinct phytolith assemblages.

As stated earlier, phytolith assemblages are compiled using a morphological approach to infer plant taxa. The need for phytolith assemblages to be recorded and interpreted for plants in this study cannot be overstated. General characteristics, for the cultigens examined, can be inferred from the analysis of various diagnostic phytolith types. The occurrence of phytoliths within plant anatomy

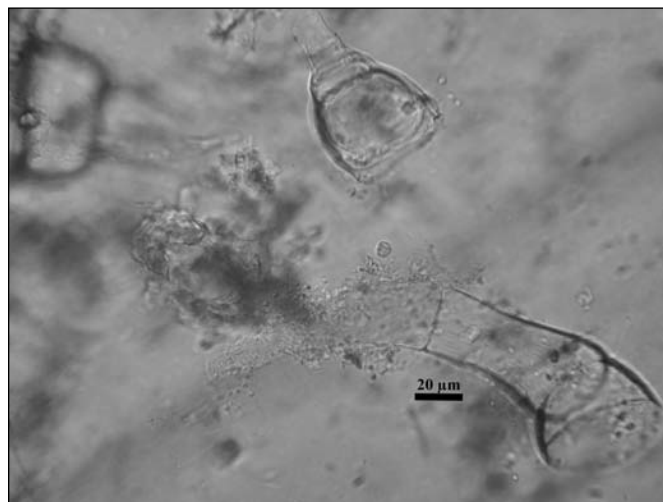


Figure 8-11. Phytoliths from a leaf of *Cucurbita foetidissima*

is both multiple and redundant. Classification systems of phytoliths are based on statistical averages and assuming normal distributions. A good example of this archaeological method is documented in Hart et al. (2003, 2007) and Thompson et al. (2004). The authors concluded that assemblages of rondel phytoliths from archaeological contexts can be identified to grass species through statistical comparison with assemblages from modern plants. This work was also conducted in New York. Due to biological variability within the cell, the average population is presented. Unique typologies, though, often do not exist for closely related taxa, which led Ball and associates (1996:619, 2001:289) to approach phytolith classification using discriminant functions. He developed a classification key based on mean morphometric differences of phytoliths occurring in the inflorescences of wheat and barley. Upon doing so he came to the conclusion that the measurements of the phytoliths produced by different taxa often have differing morphometric ranges. Arlene Miller-Rosen applied a similar method of classification (Rosen 1992). She examined the epidermal tissue from the culm and inflorescence bracts of wheat and barley to ascertain the differences in taxonomic identification. Variations in the shapes and types of phytoliths produced in different parts of a single plant species and between species were observed allowing inferences about crop processing, activity areas, and room functions to be made.

These systematic methods can be directly applied to four plant species in the current study, i.e., *Elymus virginicus*, *E. canadensis*, and *E. caninum*. The inflorescence bracts of these plants appear to produce unique dendriform cells, which could make identifying the cereal flower possible. The methodological approach of uniformitarianism is applied based upon wheat and barley research by Ball et al. (2001:390) and Rosen (1992:129). Interestingly, however, *Hordeum pusillum* (little barley) examined in this study did not produce similar silica skeletons to *Hordeum vulgare* (common barley). In addition, the phytoliths produced in the leaves, culm, glume, lemma, and palea are discernable in wheat and barley, and may be for additional plants. For instance, the value of analyzing the waves of dendriform phytoliths and the papillae phytoliths in wheat and barley have been successful in supplying valuable and discriminating information for the systematics of phytolith analysis (Rosen 1992) and may be applied to similar plant taxa, such as *Elymus* spp. Information gleaned from the phytoliths occurring in different parts of the plant can be used to make inferences about how the plant was used, activity space and crop processing of past societies. It is useful, and greatly needed, to develop a functional taxonomy for identifying phytoliths of major domesticated cultigens for the benefit of future archaeological research.

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CHAPTER 9

STARCH GRAIN ANALYSIS: METHODOLOGY AND APPLICATIONS IN THE NORTHEAST

by *Timothy C. Messner, Ruth Dickau, and Jeff Harbison*

Plants played an essential role in the lives of Native Americans. Analyses that provide data on what species were being exploited during specific time periods allow researchers to answer broader questions regarding Native American resource selection, ecological interaction and manipulation, inter-regional group relationships via trade and exchange, and change over time in subsistence strategies. Advances in archaeobotanical inquiry thus offer the opportunity to improve our understanding of many aspects of prehistoric human life (e.g., Asch Sidell 2002; Hart 1999a, 1999b, 2001; Hart et al. 2002; Hart and Asch Sidell 1997; Schulenberg 2002; Thompson et al. 2004).

Starch grain analysis is a methodology that uses ancient microfossil residues isolated from plant processing tools, ceramics, and sediments, to identify economic taxa, determine artifact function and culinary practices, and aid in paleoenvironmental reconstructions. A significant number of economic seeds, subterranean storage organs, and fruits contain carbohydrates in the form of starch. For this reason, these plant organs were the focus of many Native American subsistence practices. Processing of these tissues often left starch grains embedded within the surfaces of tools or in residues on ceramic pots. In these archaeological contexts, starch grains have the potential to preserve for extended periods of time in environmental conditions otherwise poorly suited for organic preservation (Loy et al. 1992). Starch grain analysis offers archaeologists the ability to augment the list of economic species used at an archaeological site by providing evidence of plant species that seldom become carbonized, lack identifiable characteristics, or do not produce diagnostic phytoliths or abundant pollen. It provides a powerful new technique in archaeobotanical inquiry, particularly when combined with other types of analyses.

The rapid development of starch grain analysis within archaeology over the past decade has resulted in a significant amount of literature on general aspects of this

methodology. Rather than simply review the details of this literature in this chapter, we will explore the conceptual and methodological framework specific to starch grain analysis as it applies to northeastern archaeology. Several case studies conducted in the Upper Delaware Valley of Pennsylvania and New Jersey are used to highlight aspects of starch research in the Northeast. Each example illustrates the potential contexts from which starch can be isolated, the taxa this sort of analysis is likely to recover, and the interpretations made possible by the application of this kind of analysis.

STARCH GRAIN BIOLOGY

The following is a brief overview of starch grain biology as it generally applies to archaeological starch research. For more in depth detail on starch grain chemistry and physiology readers are directed toward Badenhuizen (1965; 1969), Franco et al.(1992), Galliard (1987), Gott et al.(2006), Sterling (1968), Torrence (2006), and Wang et al. (1998).

Many vascular plants produce and use starch as a means of preserving energy. Starch can generally be categorized into two different types (Haslam 2004; Loy 1994). The first, transitory starch, is produced from glucose in the chloroplasts during photosynthesis and is converted back into sugars at night and distributed throughout the non-photosynthetic portions the plant (Cronquist 1982; Gott et al. 2006). Starch of this type is generally small and featureless and therefore of limited use in starch grain analysis studies (Loy 1994, Perry 2001; but see Gott et al. 2006 and Haslam 2004 for perspectives on its utility).

The second type, storage or reserve starch, is produced in amyloplasts and stored within seeds, roots, rhizomes, tubers, corms, and bulbs. It provides a source of energy during seasonal periods of poor growing conditions or for processes with high energy requirements such as

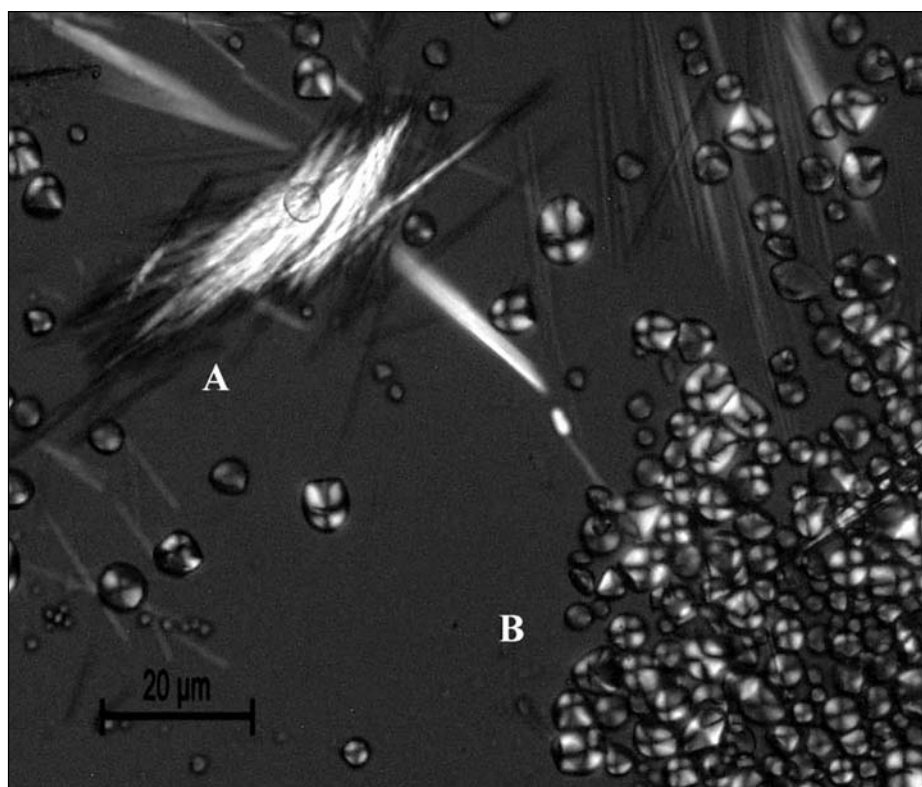


Figure 9-1. Calcium oxalate crystals (A) and starch grains (B) from an *Arisaema triphyllum* (Jack-in-the-pulpit) corm, viewed with cross-polarized light.

germination, tissue repair, or rapid growth (Haslam 2004). Botanists have recognized for some time that starch grain morphology is often distinctive for different plant taxa (McNair 1930; Reichert 1913). Only recently have archaeobotanists begun to capitalize on this aspect of reserve starch, with the discovery that starch grains can preserve in archaeological contexts.

Starch is a polysaccharide composed of two molecules known as amylose and amylopectin. The latter composes the largest percentage (75–85%) of most starches and has a branch like appearance (Manners 1968). In contrast, amylose, the minor component, is essentially a linear arrangement of glucose molecules (Manners 1968:67). Branches of the semi-crystalline, “bush-like” amylopectin form in alternating layers with the amorphous amylose (Gott et al. 2006). It is thought that this semi-crystalline structure is responsible for causing birefringence, or the formation of an interference cross, when viewed under a microscope using cross polarized light (Blanshard 1987; French 1984). This highly ordered quasi-crystalline molecular framework tends to: (1) preserve for extend periods of time due to its insolubility in cold water, and (2) resist enzymic degradation (Colonna et al. 1987; Haslam 2004). The resilient structure of starch, coupled with the ability of researchers to identify family, genus,

and often species-specific forms, makes starch grain research a powerful tool in archaeobotanical analysis.

RESEARCH POTENTIAL OF STARCH GRAIN ANALYSIS

Many processing activities associated with the preparation of plants for consumption tend to break down tissues into forms that are rarely preserved or are unrecognizable as macrobotanical remains. However, some of these activities tend to promote starch grain deposition and preservation on artifacts. Processing may take place to render certain plants edible (such as removing toxins or acridic protease attached to oxalate crystals), as a means of increasing palatability (removing tannins); or often it may simply have been part of cuisine preparation and cultural taste for certain products (such as producing refined, storable, flour) (Berzok 2005; Johns 1990; Stahl 1989).

Many plants used as food come from families that produce toxic or unpalatable substances (Moerman 1994). For instance in the Northeast the subterranean storage organs of *Orontium aquaticum* (golden club), *Arisaema triphyllum* (Jack-in-the-pulpit), and *Peltandra virginica* (tuckahoe) all represent viable food sources. However, they



Figure 9-2. Experimental tools used to process plant material and residue embedded in stone mortar (or nutting stone) as the result of *Quercus* (acorn) cracking.

must first be dried and finely ground to remove the acrid factor attached to calcium oxalate crystals (Figure 9-1A) before being consumed (Paull et al. 1999; Peterson 1977). Additionally, the *Quercus* subgenus *Erythrobalanus* (red oaks) contains significant quantities of tannin that must first be removed before the starch rich meat is deemed edible. Native groups are described as using several methods for removing tannins (see Mason 1992; Petruso and Wickens 1984). For instance, Scarry (2003:66) describes the Iroquoian method of boiling nut meats in conjunction with ashes. Once the tannins are removed the meat could then be finely ground and used as flour for bread or to thicken gruel (Swanton 1969).

Processing also took place to satisfy cultural taste. Waugh (1916:80) describes the Iroquoian process of making corn cakes. Maize kernels were first ground and winnowed into a fine flour. A thick paste, resulting from the addition of water, was then kneaded with the hands and dried huckleberries, blackberries, elderberries, strawberries or beans were added to the mixture. These cakes were then boiled in pots for approximately one hour before consuming. Whether plants were processed out of necessity or desire, these activities produce potential residues on the surfaces of the tools used to carry them out.

Stone tools compose the bulk of the archaeological record in eastern North America, and their role in plant processing is most readily accessible. Activities such as grinding, milling, peeling, and slicing, sever or rupture cellular matter and deposit residue upon the surface of the tool (Figure 9-2). Ground stone, modified and unmodified cobbles, formal and informal chipped stone, and

expedient flake tools could all potentially be used to process plant matter and therefore represent prime locations to recover starch residues. Analyses of these tools can either (1) focus on individual working surfaces to isolate microfossil residues associated with specific tasks, or (2) sample the entire artifact when research questions focus on determining the full range of species processed by the tool.

Pots used in the thermal alteration of plant matter (e.g., boiling, roasting, and poaching), provide additional contexts from which starch residues potentially can be recovered. Recent research in the Northeast has focused on carbonized cooking residues adhering to ceramic pots as contexts from which microfossil residues such as phytoliths can be extracted, identified, and dated (Hart et al. 2003, 2007; Thompson et al. 2004). Starch grains also have been shown to preserve in recognizable forms within carbonized residues. Starch commonly gelatinizes (looses structural integrity, produces exudates) when exposed to heat; however, this is variable depending on species and heating conditions. Colonna et al. (1987) demonstrate that starch can preserve in varying temperature ranges depending on moisture content and botanical origin. In their experiments, starch with low moisture content (1–3%) experienced only minor decomposition in temperatures reaching up to 180°C. But grains with high moisture content (60%) were completely gelatinized at temperatures as low as 70°C (Sair 1967). Gelatinization temperatures vary between species (Chandler-Ezell et al. 2006; Colonna et al. 1987; Gott et al. 2006; Reichert 1913). The preservation of starch within carbonized cooking

residues is therefore possible on archaeological pots, depending on moisture content and temperature ranges during the process of cooking. Starch preserved within this residue not only provides insight into the Native American dietary composition, but culinary practices as well. Moreover, carbonized residues can be directly dated using the AMS method.

Ceramic sherds lacking visible evidence of cooking residues may also yield identifiable starch grains. Ground, carbohydrate-rich plant matter stored in a pottery vessel may result in starch residue being embedded within the micro-topography of the vessel's interior. Preserved starch can also be recovered from archaeological sediments (Atchison and Fullager 1998; Lentfer et al. 2002; Therin et al. 1999), human dental calculus (Cummings and Magennis 1997; Juan-Tresserras 1998), coprolites (Horrocks 2004), and macrobotanical remains (Ugent et al. 1981, 1982), although no studies in eastern North America have yet included these sources.

STARCH GRAIN ANALYSIS: USES, EXTRACTION METHODOLOGY, AND CONCERNS

Cortella and Pochettino (1994) and Loy (1994) were among the first to discuss in detail the methods and concerns of starch grain analysis in archaeology (see also Ugent et al. 1984). Recent advances have since greatly expanded the methodology and applications (Perry 2001; Piperno and Holst 1998; Torrence and Barton 2006). Starch grain analysis has been used extensively in equatorial regions as a means of studying people and plant interactions. Throughout the South Pacific and in Central and South America researchers have used starch to look at such things as: spatial distributions of activity areas (Blame and Beck 2002), stone tool function and plant processing (Atchison and Fullager 1998; Babot 2001; Barton et al. 1998; Fullager et al. 1998; Fullager et al. 1999; Perry 2002a, 2004; Piperno et al. 2004), paleoenvironmental reconstruction (Horrocks and Lawlor 2006; Lentfer et al. 2002), and domestication, agriculture, and the dispersal of crops (Chandler-Ezell et al. 2006; Dickau 2007; Fullager et al. 2006; Pearsall et al. 2004; Perry 2002b; Perry et al. 2007; Piperno 2006; Piperno et al. 2000). As the number of citations above suggests, starch can be used to investigate a wide range of archaeological questions, and the ability to recover starch from different contexts further contributes to the potential of this research methodology. In North America, starch grain analysis has recently provided insight into prehistoric subsistence strategies in the temperate regions of the Eastern Woodlands (Messner and Dickau 2005) and the Canadian Great Plains (Zarrillo and Kooyman 2006). This research highlights the potential of

this methodology for detecting evidence of plant processing activities and increasing the number of archaeologically visible plant species.

Modern Reference Collection

Modern reference collections are a critical aspect to all types of archaeobotanical analyses. Accurate identifications cannot be made unless a reference collection, specific to the geographic area in question, has been established. This holds true for starch grain analysis as well. Researchers need to be familiar with the range of variation present within starch grain forms specific to the floral composition of each region. Furthermore, taxa from different climatic regimes should also be studied to account for vegetation changes through time.

A starch grain reference collection composed of plant species indigenous to both the Middle Atlantic and Northeast regions and known domesticates was begun in 2004 by Messner and is currently housed at Temple University, Philadelphia. Samples for this comparative collection were obtained from the field, from the Academy of Natural Sciences herbarium (ANS) and from the USDA Agricultural Research Service. Field samples were gathered from throughout both regions following guidelines established by Pearsall (2000). Detailed notes were taken on all specimens including the local environment from which samples were collected, date, soil type, geomorphic landscape and associated vegetation. Identifications were made using taxonomic manuals such as Rhoads and Block (2000). Botanists at ANS were consulted in instances of uncertainty and voucher specimens are housed at Temple University's anthropology laboratory and the ANS herbarium. Secure identifications were also established from all material sampled at the ANS herbarium. Plant species were selected based on their inclusion as economic taxa within ethnographic, ethnohistoric, and secondary sources (such as Crawford and Smith 2003; Densmore 1974; Gilmore 1977; Roundtree 1997; Scarry 2003; Tantaquidgeon 1971; Yarnell 1964). Multiple specimens, when available, were gathered for each species as well as congeneric species. Starch grains assembled for this collection can be referenced either in digital image format or through slide preparations and examination.

Extraction of Archaeological Starches

Researchers have used several procedures to extract starch from archaeological contexts. Selection of the appropriate procedure depends on research goals and artifact type. Detailed information regarding extraction methods is available from numerous sources, including Loy (1994), Piperno and Holst (1998), and Torrence and Barton (2006). We briefly describe the procedures we have used in the analysis of archaeological material from sites

in the Upper Delaware Valley of the Northeastern region.

Starch was extracted from stone tools using sonication. This method involves sampling the entire artifact for the presence of starch residues. Stone tools are placed in a sterile beaker and covered in distilled water. Beakers are then placed in an ultrasonic bath and sonicated for five minutes. After removing artifacts, beakers are covered and left to allow gravity settling of residues and sediment for 24 hours. The majority of water is decanted. Sediment is concentrated using centrifugation (cycles of 2500 rpm for 15 minutes) and the remaining water removed. A heavy liquid solution of cesium chloride (CsCl) prepared to 1.8 specific gravity is added to each tube. The sample is agitated to mix the CsCl and sediment, and then centrifuged at 2500 rpm for 5 minutes. This allows for the flotation of potential starch grains from the heavier sediment. Two ml of solution is aspirated from the top of the CsCl and placed into a sterile tube. Once separated, the extracted material undergoes a series of rinse cycles to dilute the CsCl, and permit starch residues to fall from suspension and accumulate at the bottom of the tube. Samples are mounted on microscope slides for scanning.

Starch residues may be visible, either macro- or microscopically, in the cracks and crevasses of plant processing artifacts. In instances such as this, starch grain analysis focused specifically on the working surfaces of a stone tool or artifact can provide evidence of plant use without cleaning the entire tool in an ultrasonic bath. Spot sampling is useful for identifying working surfaces on artifacts, and testing interpretations made based on use-wear analyses (e.g., Barton et al. 1998; Perry 2001, 2002a; Fullagar 1993). To carry out this procedure, a drop of distilled water is placed on the working surface and allowed to saturate the area thoroughly. A pipette is then used to agitate the working surface by repeatedly forcing water into the micro-topography of the artifact. The solution is then pipetted into a sterile test tube and the flotation and rinsing protocol described above is carried out. Blind spot sampling, meaning there are no visible residues on the working surfaces of tools, has also been shown to be successful for spot sampling studies (Perry 2002a).

Ceramic sherds with visibly encrusted food residue can also be spot sampled (Harbison and Dickau 2006). During investigations carried out at Shoemaker's Ferry, residue was scraped into a small beaker, and distilled water was added. The residue was then sonicated to break up the residue and free any trapped starch grains. Starch was separated using heavy liquid flotation as described above. Sonication of sherds may also be a possible extraction method, particularly for ceramic sherds that do not exhibit visible residue. Initial trials by Messner and Harbison on the effects of sonication on ceramic material indicate that short periods (<10 minutes) of exposure to ultrasonic waves do not adversely affect the sherds. These

tests were conducted on ceramics composed of a hard paste with temper ranging from grit to crushed quartz. Further experimentation is advised before sonicating ceramics tempered with shell or composed of a soft or seemingly friable fabric.

Sediments can also be examined for the presence of starch grains. After trowelling a fresh surface, a sterile container can be pressed into the soil. Excavation can then resume around the cup until it has remained pedestaled. The cup can then be flipped over and sealed until analysis. In addition, standard sediment column samples can be subdivided for pollen, phytolith, and starch analysis. Sampling methodologies for microfossils in sediment are more fully described in Pearsall (2000). Protocols described above for flotation and rinsing are used for isolating starch grains from sediments. Depending on the nature of sampled sediments, pretreatment with a defloculant may be required to disperse clays. Sonication of the sediment mixed with de-ionized water is also recommended to fully break apart peds and free any starch grains. Because of the potentially destructive nature of heat or certain strong chemicals on starch grains, starch extraction should be done separately from other microbotanical extractions, or in a carefully considered methodology for combining extraction techniques (Chandler-Ezell and Pearsall 2003; Coil et al. 2003; Horrocks 2005).

The use of starch for industrial purposes can potentially lead to contamination of archaeological samples. For this reason the extraction and analysis of archaeological starch grains must be conducted within a controlled environment and the post-excavation history of the artifact in question must be known. Potential sources of contamination include (1) equipment and materials coming into contact with samples (including water), (2) reference collection, (3) air conditioning, and (4) food. To avoid these potential hazards the laboratory in which starch grain analysis is conducted must be constantly monitored and completely isolated from where the reference collection is stored. Sterile slides should be strategically positioned throughout the lab and regularly scanned to control for possible airborne contaminants (Loy and Barton 2006:165). All equipment (glass ware, aluminum foil, racks, bottles, etc.) used during processing should first be tested for the presence of starch and subsequently sterilized. Latex gloves of all types are not recommended for use during analysis; modern starch may be present on these from manufacturing processes, in spite of "powder free" labels, a concern also put forth by Loy and Barton (2006:165–166).

Taxonomic Identification

Messner has examined starch grain assemblages from 34 different families representing 62 genera and 120 species of economic plants from the Northeast thus far, including

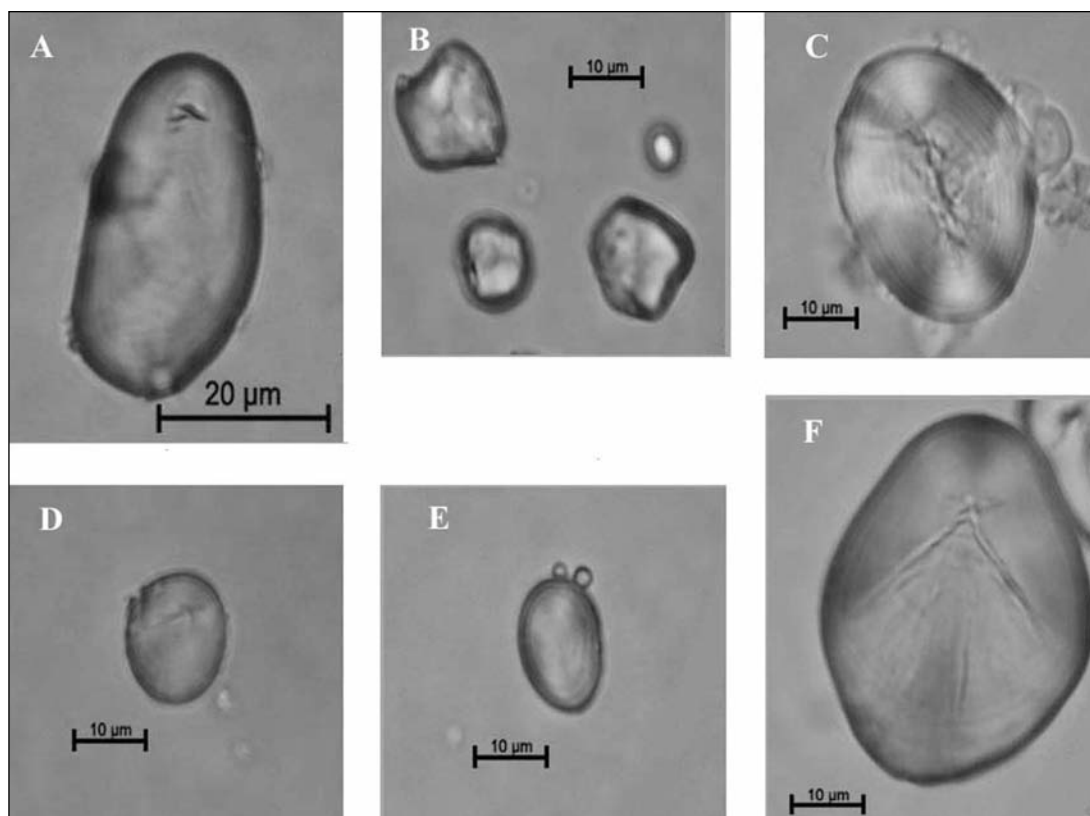


Figure 9-3. Examples of modern starch from reference specimens. (A) *Peltandra virginica* (tuckahoe, arrow arum) root starch, (B) *Zea mays* var. Parker's Flint (maize) starch, (C) *Phaseolus vulgaris* (bean) starch, (D) *Nelumbo lutea* (American lotus) root starch, (E) *Nelumbo lutea* (American lotus) seed starch, (F) *Lilium superbium* (Turk's cap lilly) root starch.

tissue from subterranean storage organs, fruits, and seeds. Numerous taxa from within the comparative collection can be recognized on a genus, and often species level of identification (Figure 9-3). Domesticated maize (*Zea mays* ssp. *mays*) and bean (*Phaseolus vulgaris*) each can be readily distinguished from other taxa within their respective families. In addition, the most widely cited “root” resources of the Eastern Woodlands (e.g., *Sagittaria* sp., *Peltandra virginica*, *Apios americana*, *Nuphar advena*, *Nelumbo lutea*, *Lilium* sp., and *Erthyronium* sp.) all produce morphologically distinguishable forms. In addition to this comparative work, Zarrillo and Kooyman (2006) describe the diagnostic characteristics of starches from a suite of fruits used by Native groups on the Canadian Plains, several species of which have distributions that cover portions of the Northeast, such as *Prunus virginiana* (chokecherry), *Prunus pensylvanica* (pin cherry), *Rubus idaeus* (American red raspberry), and *Rosa acicularis* (prickly rose). In addition, several taxa of mast produce readily identifiable starch grains. Scarry (2003) provides dietary values for each of the mast species of the Northeast. Those species with high fat and protein values also tend to have very little visible starch, i.e., walnuts

(*Juglans* sp.) and hickory (*Carya* sp.). In contrast, carbohydrate rich taxa such as oak (*Quercus* sp.), American chestnut (*Castanea dentata*), and chinquapin (*Castanea pumila*) tend to have abundant starch.

Archaeobotanical Collaboration

Multiple lines of archaeobotanical inquiry provide the most accurate interpretation of plant use. Microfossil datasets used in conjunction with one another offer the potential to (1) reinforce findings by providing several lines of evidence; (2) overcome weaknesses inherent within certain types of analyses by drawing on the strength of others (Reber 2006); and (3) provide a more complete list of the taxa used in the past (Pearsall 2000; Piperno 1995, 1998). For instance, it has been demonstrated that encrusted food residues adhering to ceramic pots allows for the recovery of an array of microfossils or chemical signatures signaling plant processing (Harbison and Dickau 2006; Hart et al. 2003, 2007; Reber 2006; Schulenberg 2002; Thompson et al. 2004). Testing for the presence of multiple residue types can therefore corroborate identifications of these plant species. Moreover, certain plant species may produce more readily identifiable microfossils than

others. For instance, phytoliths may be better suited to document genera such as wild rice (*Zizania*), which has tiny (2–7µm), nondescript starch grains (Lorenz 1981; Wang, et al. 2002). Alternatively, species such as American lotus (*Nelumbo lutea*) or genera such as oaks (*Quercus*) each produce large amounts of starch in their edible parts with distinctive forms that are easily recognized using starch grain analysis.

Sampling for macrobotanical remains has become an almost universal procedure in archaeological investigations throughout the Eastern Woodlands. Since the “flotation revolution” several decades ago (Struever 1968), our understanding of people and plant interactions has increased substantially (Asch and Asch 1985; Fritz 1997; Hart et al. 2002; Smith 1992; Smith and Cowan 1987; Yarnell 1972, 1993, 1994). In spite of these vast improvements, preservation biases exist which hinder our ability to fully understand the range of economic taxa exploited prehistorically. Organic preservation in open-air archaeological sites of the Northeast is often poor. Evidence of macrobotanical remains is therefore contingent upon carbonization. Wright (2003) describes three variables responsible for influencing whether or not, and in what condition, macrobotanical remains will become carbonized: (1) the species and organs in question, (2) moisture and or chemical content at time of transformation, and (3) the characteristics of the exposure itself (temperature, duration, oxidation versus reduction). Furthermore, Wright (2003:581) states: “the assumption that the more a particular plant part is used, the higher the likelihood of it becoming a carbonized plant remain oversimplifies the process.” Caution must therefore be taken when formulating dietary reconstruction based solely on macrobotanical findings.

As mentioned, these obstacles can be partially overcome through the use of multiple lines of archaeobotanical inquiry. Starch grain analysis used in conjunction with other archaeobotanical datasets can significantly increase the visibility of those carbohydrate rich economic species that were commonly processed. Not only does it often help corroborate evidence of various species visible in other records, but more significantly, it allows us to investigate many economic species seldom represented in the archaeobotanical record, especially roots, tubers, subterranean stems, and soft fruits.

“Root” resources help illustrate this point. Early ethnohistoric accounts, such as those written by Waugh (1916), Zeisberger (1910) and Newcomb (1956), record numerous plants that Native peoples were observed consuming, but which are rarely identified in the archaeobotanical record. Ethnographic and secondary sources (such as Crawford and Smith 2003; Densmore 1974; Gilmore 1977; Roundtree 1997; Scarry 2003; Tantaquidgeon 1971; Yarnell

1964) further demonstrate this discrepancy: each of their lists of known economic taxa far outnumbers those species commonly encountered in the macrobotanical record. These differences are especially apparent for those taxa exploited for their roots, tubers, rhizomes, corms, and bulbs. Table 9-1 is a compilation of economic (both dietary and medicinal) “root resources” derived from the aforementioned sources for which there is sparse, if any, archaeological evidence of exploitation (see Leonard 1996 for exception). A large percentage of these taxa produce starch as their primary reserve carbohydrate and therefore may be archaeologically visible using starch grain analysis.

LATE WOODLAND PLANT USE IN THE UPPER DELAWARE VALLEY

The Delaware River drains portions of southeastern New York, northeastern Pennsylvania, New Jersey, and northern Delaware. The archaeology of this watershed has been the focus of professional archaeologists for decades with seminal works by Custer (1996), Kinsey (1972), Kraft (2001), Moeller (1992), Stewart (1990, 1993), and Stewart et al. (1986). This watershed is geographically important as it represents a major waterway separating the Atlantic coast from the upland environments to the west and north. The Late Woodland period (ca. A.D. 1000–1600) of the Upper Delaware Valley (UDV) is marked by material representations of interaction with neighboring areas. Throughout this portion of the watershed, stylistic similarities can be seen extending further north into New York, west into the Susquehanna drainage, east toward the Atlantic coast, and south into the Middle and Lower Delaware Valley (Kinsey 1972; Stewart 1989). Subsistence economies in this region are described as depending heavily upon fish, game, and “wild” plants until the Late Woodland period when maize-centered farming became a part of this economic repertoire (Kraft 2001; Williams et al. 1982).

The earliest macrobotanical evidence of farming in the UDV was recovered from the Smithfield Beach site where carbonized remains of *Cucurbita* sp. (Fischler and French 1991) and *Zea mays* (maize) were found in association with charcoal dating to 1020±80 B.P. (cal 2σ A.D. 724–1212) and 1060±60 B.P. (cal. 2σ A.D. 782–1152). These findings agree with other dated contexts throughout the Delaware Valley where maize has been recovered (Stewart et al. 1986; Williams et al. 1982). Recent starch grain analysis on ceramics in this watershed has provided the first directly dated maize residues from the early Late Woodland period (ca. A.D. 1000) and has increased its visibility in the UDV archaeological record during the Late Woodland.

Table 9-1: Subterranean storage organs, ethnographically and ethnohistorically documented as utilized by Native groups of the Eastern Woodlands. *Note:* Taxa compiled from Densmore (1974), Gilmore (1977), Roundtree (1997), Scarry (2003) and Yarnell (1964)

Dietary- Scientific Name	Common name	Family	Medicinal-Scientific Name	Common name	Family
<i>Acorus americanus</i>	sweetflag	Acoraceae	<i>Acorus americanus</i>	sweetflag	Acoraceae
<i>Allium canadense</i>	meadow garlic	Liliaceae	<i>Actaea rubra</i>	red baneberry, snakeberry	Ranunculaceae
<i>Apios americana</i>	groundnut	Fabaceae	<i>Adiantum pedatum</i>	maidenhair fern	Pteridaceae
<i>Amphicarpaea bracteata</i>	hog-peanut	Fabaceae	<i>Agastache foeniculum</i>	giant hyssop	Lamiceae
<i>Arisaema triphyllum</i>	Jack-in-the-pulpit	Araceae	<i>Allium stellatum</i>	wild onion	Liliaceae
<i>Cyperus esculentus</i>	chufa	Cyperaceae	<i>Amelanchier canadensis</i>	canadian serviceberry	Rosaceae
<i>Dioscorea villosa</i>	wild potato	Dioscoreaceae	<i>Anemone cylindrica</i>	thimbleweed	Ranunculaceae
<i>Erythronium sp.</i>	lillies	Liliaceae	<i>Apocynum androsaemifolium</i>	dogbane	Apocynaceae
<i>Helianthus tuberosus</i>	Jerusalem artichoke	Asteraceae	<i>Aralia racemosa</i>	spikenard	Araliaceae
<i>Ipomoea pandurata</i>	man of the earth	Convolvulaceae	<i>Asarum canadense</i>	wild ginger	Aristolochiaceae
<i>Iris versicolor</i>	harlequin blueflag	Iridaceae	<i>Athyrium filix-femina</i>	lady fern	Dryopteridaceae
<i>Nelumbo lutea</i>	American lotus	Nelumbonaceae	<i>Caltha palustris</i>	cowslip	Ranunculaceae
<i>Orontium aquaticum</i>	golden club	Araceae	<i>Caulophyllum thalictroides</i>	blue cohosh	Berberidaceae
<i>Peltandra virginica</i>	arrow arum - tuckahoe	Araceae	<i>Nymphaea odorata</i>	white water lilly	Nymphaeaceae
<i>Polygonum erectum</i>	knotweed	Polygonaceae	<i>Ceanothus herbaceus</i>	New Jersey tea	Rhamnaceae
<i>P. hydropiperoides</i>	knotweed	Polygonaceae	<i>Celastrus scandens</i>	bittersweet	Celastraceae
<i>P. pennsylvanicum</i>	knotweed	Polygonaceae	<i>Cypripedium sp.</i>	lady slipper	Orchidaceae
<i>P. ramosissimum</i>	proliferous knotweed	Polygonaceae	<i>Potentilla arguta</i>	five-finger / tall cinquefoil	Rosaceae
<i>Phragmites australis</i>	reed	Poaceae	<i>Dryopteris cristata</i>	shield fern/ crested wood fern	Dryopteridaceae
<i>Psoralea esculenta</i>	large indian bread root	Fabaceae	<i>Equisetum sp</i>	horsetail	Equisetaceae
<i>Rhexia mariana</i>	meadow beauties	Melastomataceae	<i>Euthamia graminifolia</i>	flat-top goldentop	Asteraceae
<i>R. virginica</i>	meadow beauties	Melastomataceae	<i>Gentiana alba</i>	yellowish gentian / plain gentian	Gentianaceae
<i>Sagittaria lancifolia</i>	duck-potato	Alismataceae	<i>Geranium maculatum</i>	wild geranium/spotted geranium	Geraniaceae
	(bulltongue arrowhead)				
<i>S. latifolia</i>	duck-potato	Alismataceae	<i>Hepatica nobilis</i>	roundlobe hepatica	Ranunculaceae
	(broad-leaf arrowhead)				
<i>S. graminea</i>	duck-potato (grassy arrowhead)	Alismataceae	<i>Heuchera americana</i>	alumroot/American alumroot	Saxifragaceae
<i>S. subulata</i>	duck-potato (awl-leaf arrowhead)	Alismataceae	<i>Laportea canadensis</i>	wood nettle	Purticaceae
<i>Schoenoplectus</i>	great bulrush	Cyperaceae	<i>Lathyrus venosus</i>	veiny pea	Fabaceae
<i>tabernaemontani</i>					
<i>Smilax sp.</i>	briers	Smilacaceae	<i>Lonicera canadensis</i>	fly honeysuckle	Caprifoliaceae
			<i>Osmorhiza longistylis</i>	sweet cicely, anise root	Apiaceae
			<i>Phryma leptostachya</i>	lopseed	Verbenaceae
			<i>Polygala senega</i>	Seneca snakeroot	Polygalaceae
			<i>Polygonatum biflorum</i>	Solomon's seal	Liliaceae
			<i>Potentilla monspeliensis</i>	cinquefoil	Rosaceae
			<i>Pteridium aquilinum</i>	bracken fern	Dennstaedtiaceae
			<i>Rosa arkansana</i>	wild rose/prairie rose	Rosaceae
			<i>Rubus allegheniensis</i>	blackberry	Rosaceae
			<i>Rudbeckia laciniata</i>	coneflower	Asteraceae
			<i>Sassafras albidum</i>	sassafras	Lauraceae
			<i>Silphium perfoliatum</i>	cupplant	Asteraceae
			<i>Oligoneuron sp.</i>	goldenrod	Asteraceae
			<i>Thaspium barbinode</i>	meadow-parsnip	Apiaceae
			<i>Ulmus rubra</i>	slippery elm	Ulmaceae
			<i>Urtica dioica</i>	stinging nettle	Urticaceae
			<i>Valeriana uliginosa</i>	swamp valerian	Valerianaceae
			<i>Zanthoxylum americanum</i>	prickly ash	Rutaceae

Case Study Sites

Starch grain analysis was conducted on a sample of artifacts recovered from three study sites distributed throughout the Upper Delaware Valley of Pennsylvania and New Jersey (Figure 9-4). Each site is located within the Delaware Water Gap National Recreation Area and has been investigated in cooperation with the National Park Service archaeologists.

Manna Site (36PI4). The Manna site is located three miles south of Milford, Pennsylvania and is part of the Minisink Island National Historic Landmark. The site is situated on the first terrace of the Delaware River adjacent to the current confluence of the Raymondskill Creek. Archaeological investigations were carried out as part of a cooperative agreement between the National Park Service and Temple University during the 2003–2004 field



Figure 9-4. Map illustrating locations of sites included within this study. (Map by William Schindler)

seasons (Stewart et al. 2005). Prior to the 2004 excavations it was determined that a sample of tools would be analyzed for the presence of starch residues. In preparation, the field crew was instructed to minimize handling of in situ artifacts. Four artifacts were selected from the collection for an initial trial using starch analysis. Findings from this study are briefly reviewed here; further details can be found in Messner and Dickau (2005).

All of the artifacts sampled originated in deposits stratigraphically and stylistically dating to the later half of the Woodland period (ca. post-A.D. 1100). Starch residues were isolated from two of the four artifacts analyzed. The assemblage recovered from Sample #1, a 13.4 cm x 6.5 cm elongated quartzitic sandstone cobble that appears thermally altered, consisted of simple irregular grains with often undulating surfaces and three to four fissures radiating from a central hilum in a “Y” or “X” pattern. The size range and morphology of these granules is consistent with hard endosperm maize starch.

Sample #2, a 4.7 cm thick by 17 cm x 17 cm tabular shale stone resembled a mortar or metate (Figure 9-5). The starch grain assemblage isolated from this tool consists of fourteen grains representing several different taxa. Maize starch occurs with the greatest frequency. In addition, several grains recovered were spherical to oval in plan and often lenticular to elliptical in profile, ranging from 20 to 30 μm . These grains have been tentatively identified as deriving from a type of grass. Similar forms have been seen in several genera of the Poaceae family, including *Hordeum* and *Elymus*. Further work with the comparative collection is needed before a secure identification of these grains can be made. Two starch grains exhibiting characteristics (oval to elliptical with an eccentric hilum and lamellae) of starch produced in root tissue were also recovered (Figure 9-7A and 9-7B). Although a more specific identification cannot be made at this time, these findings mark the first direct evidence of prehistoric Native peoples using subterranean storage organs in the Delaware River watershed.

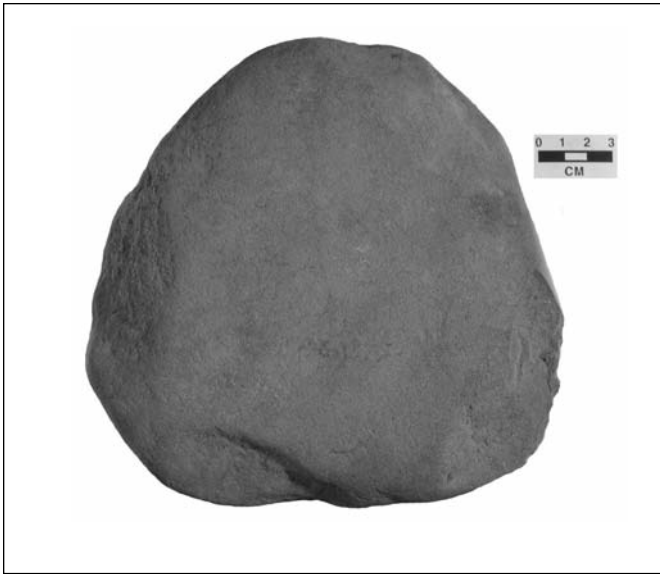


Figure 9-5: A tabular shale grinding stone (Sample #2) recovered from the Manna site.

Loch Lomond. Loch Lomond is located in the Glaciated Pocono Plateau physiographic province. This upland site is positioned approximately 122 m above, and nearly 2 km from the Delaware River. Unlike most upland sites, cultural deposits at Loch Lomond are distributed throughout the upper 50 cm of the stratigraphic profile, rather than isolated within a plowzone context. Colluvial processes were determined to be responsible for the burial of these cultural deposits. This conclusion is reinforced by the high frequency of angular rock inclusions. Loch Lomond, like many other upland sites in the Northeast, suffered from the adverse impacts of residual soil erosion and historic land-use practices, contributing to the destruction of macrobotanical remains. In an effort to overcome this bias at the site, a large, tabular, quartzitic sandstone was bagged unhandled in the field and analyzed for the presence of starch residues (Figure 9-6).

A significant quantity of starch was isolated from this artifact. The largest percentage of this assemblage consists of starch exhibiting characteristics consistent with maize (Figure 9-7D). In addition, several grains were recovered from at least two other taxa. The first is tentatively identified as originating from the Poaceae family, similar to those seen at Manna. These granules are spherical in plan-view and oval/lenticular in profile, with weak birefringence, a longitudinal fissure, and often lamellae (Figure 9-7C). The second taxon present on this tool has characteristics consistent with *Quercus*. This simple grain is somewhat oval and regular with a small "V" fissure originating from a slightly eccentric hilum. In order to secure this identification, however, a larger number of this morphotype needs to be isolated from this tool.



Figure 9-6: Grinding stone recovered from Loch Lomond.

Researchers posit that upland sites like Loch Lomond may have been used to carry out resource acquisition activities such as trade and exchange, hunting, and nut collecting (Funk 1993; Miroff 2002; Versaggi 1987, 1996). Maize kernels and cakes can be easily transported away from major habitation loci during resource procurement trips. Kernels can be ground and used to make cakes, negating the need for ceramic cooking vessels. Maize starch residues isolated from a large tabular stone provide support for this hypothesis at Loch Lomond.

Archaeobotanical research at this site has demonstrated that in spite of deleterious site formation processes commonly associated with upland environments, data can be obtained concerning subsistence practices using starch grain analysis. Based on these findings, starch and possibly phytolith and residue absorption analysis may prove beneficial for extracting data concerning the role these upland sites play within Native settlement/subsistence systems.

Shoemaker's Ferry. The site of Shoemaker's Ferry is located about six miles north of the Delaware Water Gap in Warren County, New Jersey. It is a multi-component Woodland Period site situated on a terrace over looking the Delaware River. The site was excavated in 2004 as part of a compliance study in advance of a proposed swim beach development project. The plowzone was mechanically removed, revealing a total of 2,327 features. These include numerous post molds, house patterns, pit features, and individual clusters of ceramic sherds representing the remains of discarded vessels. The Late Woodland occupation of the site dates from the

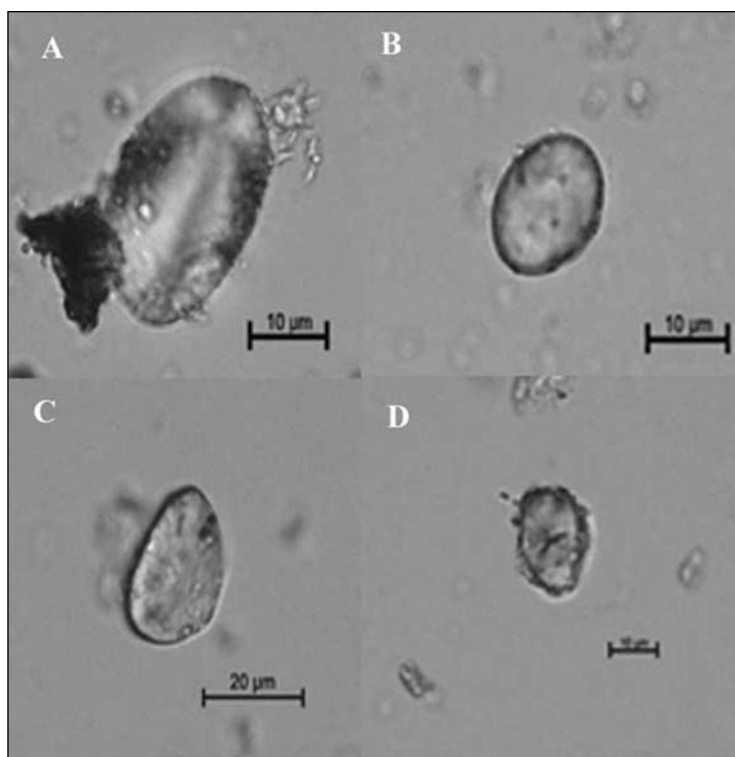


Figure 9-7: Archaeological starch grains from Manna and Loch Lomond. (A) & (B) “Root” starch recovered from the Manna site, (C) lenticular grain isolated from a stone mortar at Loch Lomond believed to originate from the Poaceae family, (D) *Zea mays* (maize) starch also isolated from the mortar at Loch Lomond.

Pahaquarra/Owasco Phase (ca. A.D. 1000 to 1300) through Minisink Phase (ca. post A.D. 1300), based on ceramic types. Artifacts recovered suggest a diverse economy. Numerous net weights indicate the importance of fishing, but unfortunately, faunal remains did not preserve. An argillite hoe blade, pitted nutting stones, and ground stone tools indicate horticulture and processing of different plant foods. Initial analysis of floated macrobotanical material from three pit features provided evidence for the use of mast species (*Quercus* sp., *Juglans cinerea*, and *Carya* sp.), economic seeds (*Polygonum* sp., *Cuscuta* sp., and *Cheno-Am* sp.) and fruit (*Rubus* sp.), as well as *Zea mays* kernels and cupules. Macrobotanical remains were restricted to Minisink aged deposits; they were not found in the earlier Pahaquarra/Owasco contexts.

As an initial test to assess the potential of starch recovery from carbonized residues from ceramic sherds, six sherds from four separate contexts were selected for starch analysis. Three residue encrusted sherds were selected from a disarticulated Owasco/Clemson Island cognate vessel (Feat. 911) with exterior cord marking and punctuates extending down the body from the rim (Figure 9-8). The remainder were selected from three different pit features dating to the Minisink Phase (Feat. 1125, 718, 1517). Two of the Minisink phase ceramics

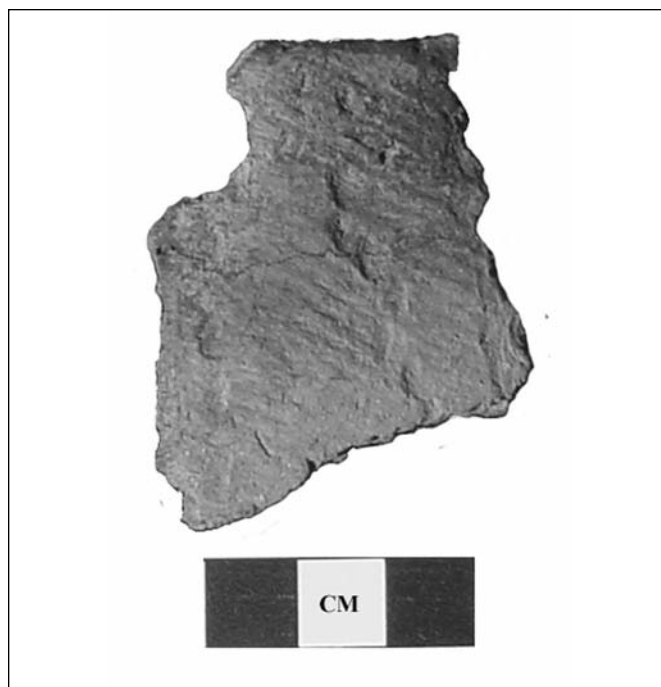


Figure 9-8. Ceramic sherd recovered from Feat. 911 at the Shoemaker’s Ferry site. Maize starch was isolated from carbonized residue adhering to interior surface and AMS dated to 1040±40 BP.

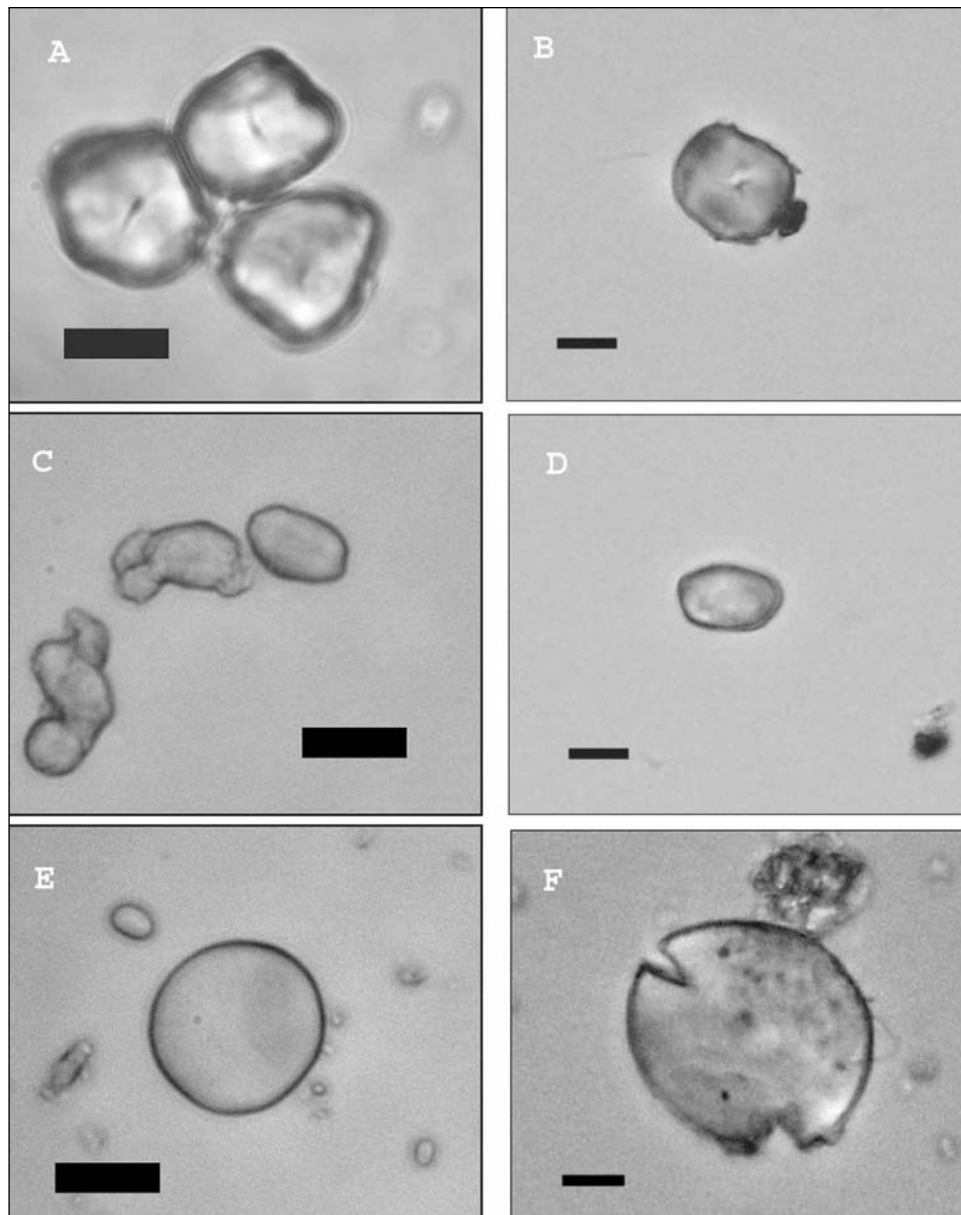


Figure 9-9. Archaeological starch from Shoemaker's Ferry and modern comparative starch. (A) Parker's Flint (modern) maize starch, (B) maize starch isolated from Sherd 3 (Feat. 911, FS 45.3, Vessel 1, #2), (C) modern *Quercus coccinea* starch, (D) starch identified as *Quercus* sp. also isolated from Sherd 3, (E) modern *Hordeum pusillum* starch, (F) damaged starch tentatively identified as belonging to the Poaceae family isolated from Sherd 4 (Feat. 718, FS 133.3).

yielded several starch grains consistent with maize, likely a harder endosperm variety based on their morphology. An assemblage of large lenticular shaped gains with centric hila and diffuse birefringence, accompanied by smaller spherical granulets, was recovered from the Feature 718 sherd (Figure 9-9F). The larger granules in this assemblage are similar to those seen in Loch Lomond and Manna, possibly belonging to the Poaceae family. Several other unidentified grains exhibited evidence of heat-damage (e.g., partial gelatinization and/or loss of extinction

cross) were recovered from the sherds, further evidence that starchy foods were being cooked in the vessels.

Maize was also found on all three sherds from the Owasco/Clemson Island pot (Feat. 911). Like the starch found in the later contexts, it appears to be from a hard endosperm type (Figure 9-9B). Other taxa were prepared in this pot as well. Two starch granules from the sherds were irregular oval in shape, slightly "bent," with an eccentric hilum and an uneven birefringence cross (Figure 9-9D). These grains have tentatively been identified as

Quercus. As with the Minisink phase samples, several heat-damaged grains were noted in the starch assemblage. A sample of the carbonized residue from the pot was AMS dated to 1040±40 B.P. (Beta 212295, cal 2σ A.D. 893-1146, δ3C -19.0‰). The isolation of maize starch from carbonized food residues adhering to ceramic sherds not only provided evidence of cultigens prepared within this vessel, but it also established a direct date on maize residues in the Upper Delaware Valley.

Summary

Starch grain analysis studies have increased the archaeological visibility of maize used within the subsistence economies of Native groups inhabiting the Upper Delaware Valley during the Late Woodland period. With increased visibility our understanding of the behaviors and technologies used to process maize, as well as the timing involved in its incorporation into Native economies can be refined. Findings from Manna and Lock Lomond provide evidence for the use of unmodified flat stones as components of maize grinding technology, while starch grains isolated from carbonized food residues at Shoemaker's Ferry establish the presence of maize within Native economies at least by the turn of the first millennium A.D. Further archaeobotanical analyses in the Delaware Valley will help document the emergence of this species into Native American economies as well as aid in determining the route, timing, and direction of its dispersal into the surrounding Northeast and Middle Atlantic regions.

Moeller (1992) reports high frequencies of macrobotanical remains of "wild" plant species recovered from Late Woodland pit features in the UDV. Findings from this study also suggest that wild plant species continued to be part of Native American subsistence economies after the adoption of maize farming practices. At least three plants other than maize are represented on the tools and ceramics analyzed during this study. These include the carbohydrate rich mast species of the *Quercus* genus, starch likely derived from some sort of root or tuber, and an assemblage of grains belonging to the Poaceae (grass) family (cf. *Hordeum* sp. or *Elymus* sp.).

In summary, this research has provided new evidence that (1) subterranean storage organs were utilized prehistorically in the UDV; (2) maize was processed in the uplands, suggesting its usage as a "transportable food" to be consumed while conducting other subsistence related tasks (Berzok 2005); and (3) maize was a part of Native diets by 1040±40 B.P. Moreover, it has demonstrated the potential of starch analysis for reconstructing diet and other aspects of human-plant interaction in the Northeast. Starch was recovered from both stone tools and ceramic residues in these initial studies, and from a variety of preservational environments. Ongoing research in the

application of starch analysis in the Northeast and continued expansion of the regional comparative collection will further increase the strength of this method in northeastern paleoethnobotany.

CONCLUSIONS

Paleoethnobotanists' ability to make interpretations regarding plant use by people in antiquity and understand human-plant relationships over time relies on the ability to recover archaeobotanical evidence—the organic residues—of plant preparation and use. In the Northeast, macrobotanical fossils have increased our understanding of prehistoric plant use, particularly as it relates to subsistence and activities associated with food acquisition, domestication, and the dispersal of domesticates into northern climates. However, data from macrobotanical remains is often limited by preservation factors.

The recent development and application of microfossil analyses has dramatically enhanced our ability to collect the basic data necessary to make interpretations regarding prehistoric plant use. One of the newest methods, starch grain analysis, offers researchers in the Northeast the means to obtain direct evidence of plants seldom seen in the macrobotanical record. For instance, a large percentage of subterranean storage organs, fruits, and seeds/nuts contain carbohydrates, primarily starch, as part of their nutritional composition. Ethnohistoric and ethnographic data suggests that many of these plant organs were processed as part of their culinary preparation. Plant processing activities can result in the deposition of starch grain residues within the micro-topography of stone tools, and on the surface of ceramics. The ability to isolate and identify starch residues from these artifacts offers researchers empirical evidence for investigating questions of plant processing techniques, resource use, foraging and farming strategies, inter-group trade and relationships, and many other aspects human behavior. This methodology, especially when used in conjunction with other archaeobotanical inquiries, offers the ability to provide a better understanding of the full range of plant species incorporated into Native subsistence economies throughout the Northeast.

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CHAPTER 10

VISIBLE CLUES: THE ANALYSIS OF VISIBLE POTTERY RESIDUES FROM NEW YORK STATE WITH GAS CHROMATOGRAPHY/MASS SPECTROMETRY

by *Eleanora A. Reber and John P. Hart*

Pottery residue analysis allows the identification of the contents of an ancient vessel, and therefore provides a unique link between vessel form and function. The concept of residue analysis is sufficiently simple that it was first proposed on a visible encrustation on a Mycenaean vase found in Egypt in 1906 (Gill 1906). It was not until the 1970s, however, that scientific instrumentation allowed analysis of the complex mixture of chemical compounds found preserved on the surfaces and within the clay matrix of archaeological vessels (Condamin et al. 1976; Mills and White 1977; von Endt 1977). Even so, the identifications made in many of these early attempts of residue analysis tended to be oversimplistic and dependent on the assumption that only one foodstuff was processed in a vessel. Increased research throughout the 1980s and 1990s, however, produced a large body of literature on both methodology and interpretation of pottery residues of various types (e.g., Beck et al. 1989; Deal and Silk 1988; Evershed et al. 1990; Evershed et al. 1987; Hastorf and DeNiro 1985; Heron et al. 1989; Hill and Evans 1987; Hurst et al. 1989).

This technique was applied to residues in the northeastern portion of North America early; Deal and Silk (1988) published an early study of absorbed pottery residues from vessels in Maine and surrounding areas, while Morton et al. (1988) performed an early stable isotope analysis on visible residues from Ontario (see also Morton and Schwarcz 2004). Another early paper examined trace elements present in visible encrustations on Iroquois pots (Fie et al. 1990). That said, organic chemical analysis of pottery residues from the Northeast seems to have gone into abeyance until the present study. This project is the first analysis of lipid residues on archaeological pottery that the authors could find published on the Northeast since Deal and Silk's (1988) early work.

As part of an intensive study of pottery chronology, technology and use in central New York (Hart and

Brumbach 2003, 2005; Hart et al. 2003, 2007a, 2007b; Hart and Lovis 2007; Thompson et al. 2004), absorbed residues were analyzed from 12 sherds, and visible residues from 16 pottery and three steatite sherds (Reber and Hart 2008; Hart et al. 2008). We limit our discussion here to the residues analyzed from pottery sherds. Eight of the sherds had both visible and absorbed residues sampled. Both types of analysis yielded information on resin sealing of pots in central New York. Although the absorbed residues yielded more information on the contents of ancient pottery, visible residues also provided information, and the sampling for visible residues was not destructive to pottery sherds. These studies suggest that the sampled pottery was largely sealed with pine resin over its use-lifetime, and used to process a wide range of resources. The pots apparently were not used to process single or unique resources.

Organic residue analysis involves the extraction of lipids that are either absorbed within the ceramic matrix of a potsherd, or preserved within visible encrustations on the surfaces of sherds. These extracted lipids are then analyzed chemically, with gas chromatography/mass spectrometry (GC/MS) being one of the preferred methods, as it allows for the separation of complex mixtures of compounds, which are found in archaeological residues, and the identification of a wide range of compounds. Once the compounds have been identified, the analyst especially tries to identify their source or sources, keeping in mind that the lipids probably underwent some degree of hydrolysis, oxidation, or microbial breakdown over the period of archaeological deposition. Despite the uncertainties inherent in this process, organic residue analysis in conjunction with analysis of phytoliths and starch grains can be used to provide direct evidence of resources processed in pottery. As such, organic residue analysis is particularly useful in studies of pottery use and food processing.

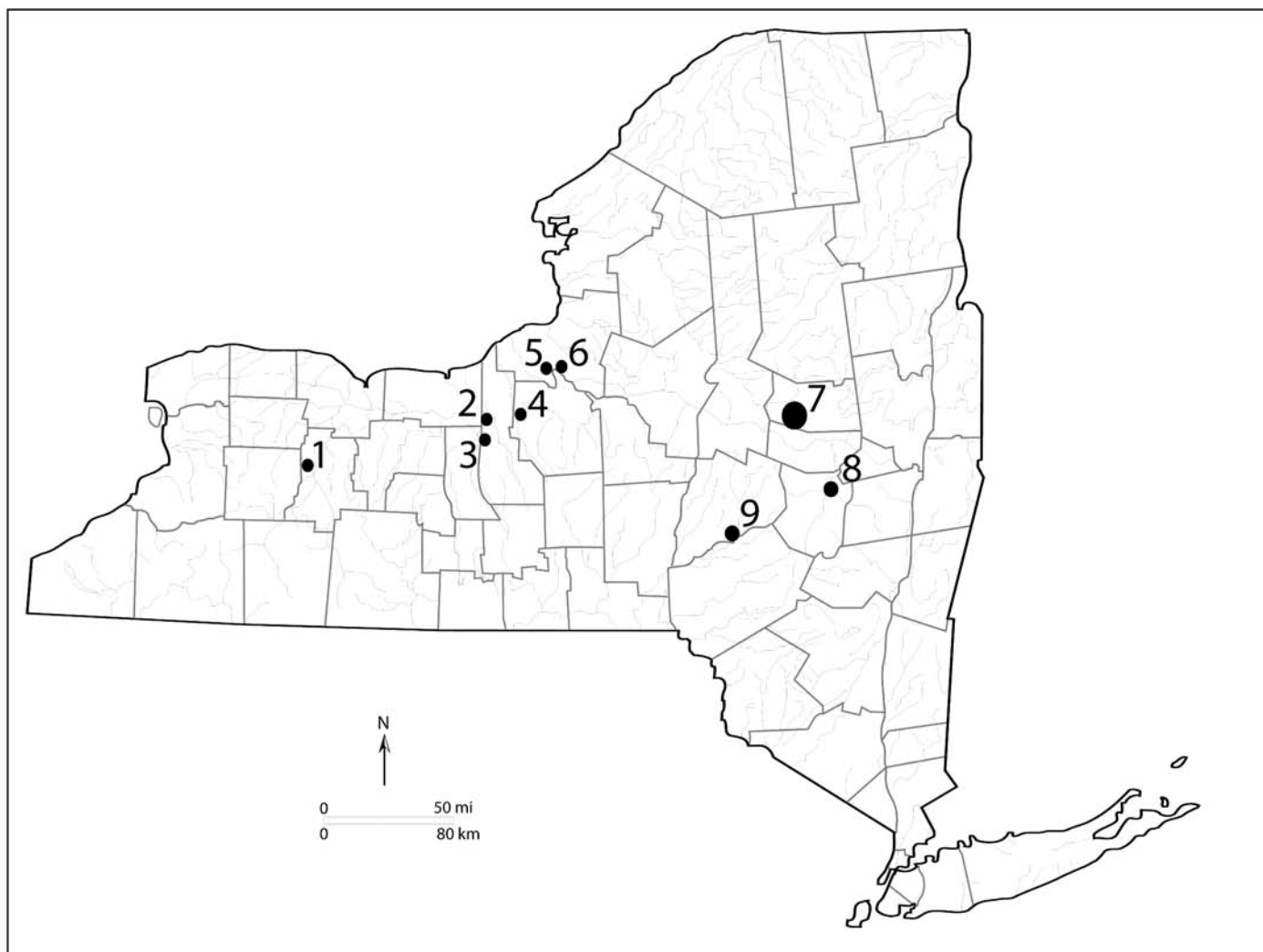


Figure 10-1. Map of sites in New York State that provided samples for this study: (1) Scaccia, (2) Hunter's Home, (3) Kipp Island, (4) Felix, (5) Wickham, (6) Vinette, (7) Garoga, Klock, (8) Westheimer, (9) Fortin 2, Street.

In this project, the samples were chosen as part of a multi-technique study of visible pottery residues on sherds from central New York State (Figure 10-1). As well as lipid residue analysis, described in this paper, the residues were also submitted for radiocarbon dating (Hart and Brumbach 2005), and phytolith analysis (Hart et al. 2003, 2007b). Phytolith analysis identified maize phytoliths in residues dating to ca. 300 B.C. In an attempt to gather further evidence of early maize in the residues, 12 samples were submitted for absorbed pottery residue analysis, and 32 samples for visible residue analysis, with some samples undergoing both types of residue analysis.

Maize, a tropical grass, utilizes C4 photosynthesis, an adaptation for faster growth in a sunny, well-fertilized environment (Hatch and Slack 1966; Hatch et al. 1967; van der Merwe 1982). One result of this type of photosynthesis is that the heavy stable carbon isotope ^{13}C is discrimi-

nated against less in C4 photosynthesis than in the C3 photosynthesis standard to non-tropical grasses in the midwestern and southeastern United States. The presence of maize (and other tropical grasses) can therefore be detected by means of measuring the stable carbon isotope ratio ($\delta^{13}\text{C}$) of a plant, a residue, or the bones of an animal or human that consumes the C4 plant, since the stable carbon isotope ratio is passed up the food chain. In an environment where maize, a C4 tropical grass, becomes a popular crop in a primarily C3 environment, such as the midwestern and eastern United States, maize can be identified in the bones of humans and animals that consume it. Because residues are comprised primarily of lipids, however, and because maize is very low in lipids (Bianchi et al. 1984), maize contribution to a residue is often heavily masked by abundant lipids from C3 sources, such as nuts and meat from animals that did not consume maize

Table 10-1. Radiocarbon dates of samples mentioned in the text (Hart and Brumbach 2005; Hart and Lovis 2007).

Site	Sherd Number	¹⁴ C Age (B.P.)	Residue cal 2σ	Component cal 2σ ^a
Scaccia	71492	2905±35	1256– 979 B.C.	1256– 979 B.C
Vinette	40047-1	2510±35	795–413 B.C.	795–413 B.C.
Felix	40701-21	2205±30	381–172 B.C.	381–172 B.C.
Vinette	40031-2	2270±35	399–208 B.C.	399–208 B.C.
Vinette	40046	1990±40	93 B.C.–A.D. 119	39 B.C.– A.D. 116
Vinette	40135	1940±35	36 BC–A.D. 130	36 BC–A.D. 130
Westheimer	44533-67	1600±35	A.D. 393–544	A.D. 393–544
Wickham	40291-3	1695±35	A.D. 252–425	A.D. 252–425
Felix	40788-3	1575±35	A.D. 413–561	A.D. 432–575
Fortin 2	46238-16	1525±40	A.D. 432–605	A.D. 434–613
Kipp Island	41119-5	1470±40	A.D. 443–656	A.D. 600–655
Kipp Island	41119-8	1428±41	A.D. 543–668	A.D. 600–655
Wickham	40525-1	1425±45	A.D. 552–667	A.D. 566–656
Felix	40727-19	1430±40	A.D. 543–665	A.D. 608–668
Felix	40677-9	1315±50	A.D. 637–860	A.D. 608–668
Wickham	40525-8	1228±42	A.D. 683–936	A.D. 683–936
Hunter's Home	48584-1	1211±46	A.D. 682–944	A.D. 772–884
Street	48217-4	1043±40	A.D. 892–1117	A.D. 892–1117
Klock	45738-43	480±40	A.D. 1327–1475	A.D. 1327–1475
Garoga	42826-2	425±40	A.D. 1417–1626	A.D. 1417–1626

^aCalibrated 2σ ranges for the component from which the sherd originated.

(Reber et al. 2004). Since maize is unusually high in the long-chain alcohol *n*-dotriacontanol, if a pot has been used to process a relatively large amount of maize, the application of compound-specific isotope ratio mass spectrometry to *n*-dotriacontanol identified in residues can identify the presence of maize components in a residue (Reber et al. 2004). This technique requires a relatively large amount of maize because *n*-dotriacontanol is a minor component of maize lipids. Therefore, a negative result in the compound-specific residue analysis does not mean that maize was not processed in a vessel, but that not enough maize was processed to produce a measurable amount of *n*-dotriacontanol. Maize was not identified in any of the residues analyzed. The project did, however, reveal some interesting information on pottery utilization in central New York State.

ARCHAEOLOGICAL BACKGROUND

Sherds were submitted to the project from 11 sites in central New York State. All sherds had visible blackened encrustations on their interior surfaces. AMS dates for samples in the text are described in Table 10-1. All sites were from central New York state, as shown in Figure 10-1, and cover a long period of pottery use in the region (see Table 10-1).

ORGANIC RESIDUE ANALYSIS

There are two types of organic residue: visible and absorbed. Visible residues are blackened encrustations on the interior of potsherds. They are often believed to result from one or more cooking episodes gone awry, resulting in a badly burned meal. As such, they are usually believed to result from a small number of cooking episodes, though this idea is not universally accepted. Lipids and other compounds are preserved within vacuoles in the carbonized residue, and can be extracted by removing the residue from the surface of the pot, and extracting the lipids with strong solvent (2:1 v/v chloroform/methanol, in this study).

Absorbed residues are compounds that are absorbed within the pores in an unglazed piece of pottery. It is generally believed that absorbed residues include compounds from the entire use-lifetime of a pot, though it is possible that there is a saturation point at which further compounds cannot absorb into the pot walls. Absorbed residues are extracted from their surrounding ceramic through destructive testing. The sherd is powdered in a mortar and pestle, ultrasonicated in strong solvent (again 2:1 v/v chloroform/methanol in this study), and the solvent is then centrifuged and filtered to remove residual ceramic powder.

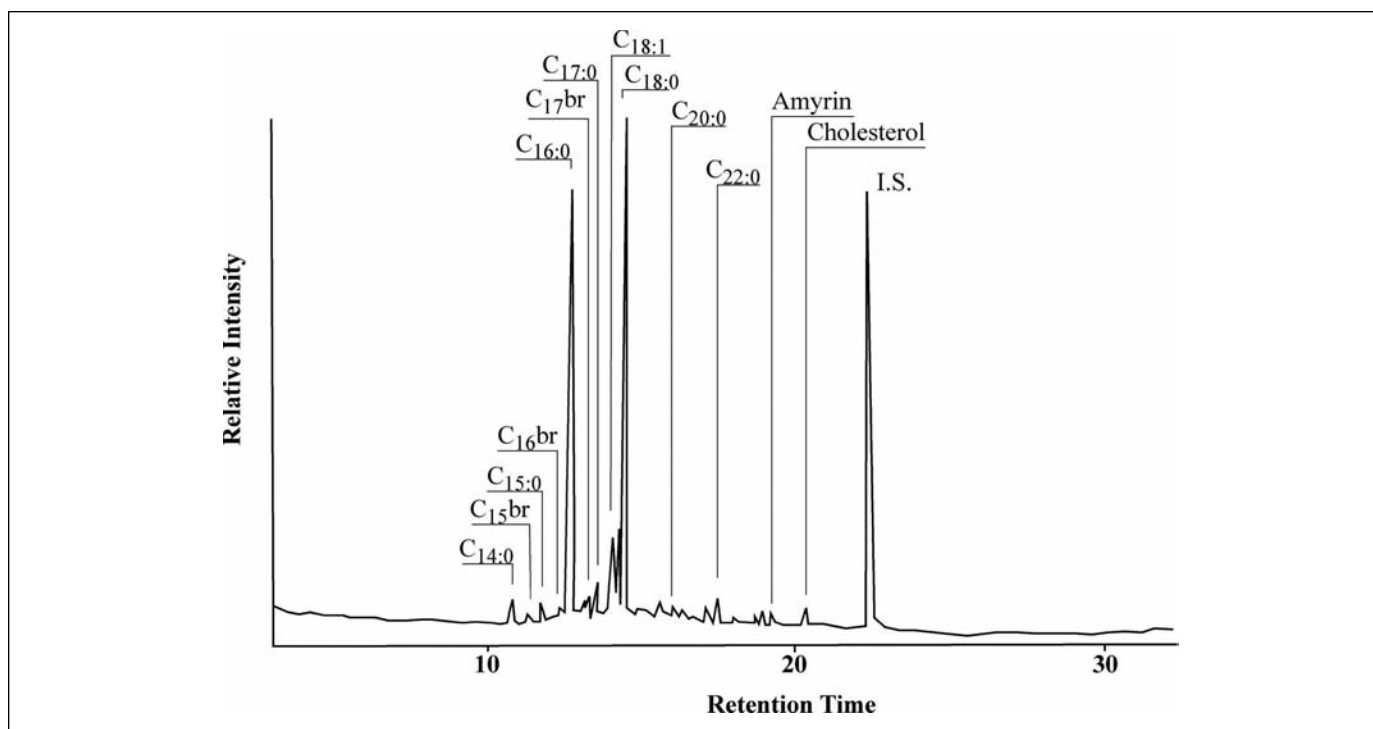


Figure 10-2. Total Lipid Extract (TLE) of a visible residue from Vinette 40046. It shows the full range of compounds present in the residue, including amyirin, typical of non-tree plant resin, and cholesterol, a biomarker for the presence of animal products. Fatty acids are indicated by a C with the number of carbons and unsaturations noted in subscript—C_{14:0} is a fatty acid with 14 carbons and 0 double bonds. I.S. indicates the internal standard.

Different processes preserve compounds in visible and absorbed residues. Absorbed residues tend to be compounds hydrophilic enough to dissolve in cooking liquid and thus absorb into pot walls, but hydrophobic enough that they do not wash out of those walls during archaeological deposition. Functionally speaking, lipids make up the large majority of these residues. Visible residues do not necessarily have to dissolve in water; they merely need to be preserved in carbon following a burned meal, and be hydrophobic enough to not wash out in groundwater. Visible residues, therefore, tend to produce a wider range of compounds, though lipids still make up the largest, and most easily identifiable, portion of these residues.

Clearly, analysis of absorbed and visible residues have various benefits and drawbacks. Visible residues are comprised of a wider range of compounds, and are (probably) a snapshot of a small number of cooking episodes. Absorbed residues contain a smaller range of compounds, primarily limited to lipids, but come from a larger range of pottery use. Absorbed residue analysis is destructive to pottery sherds, while visible residue analysis is destructive only of the encrustation, not of the entire potsherd. The final difference between these two types of residues is in preservation; in general, absorbed residues have much better yield and therefore give more com-

pounds for analysis than visible residues, which are necessarily limited by the amount of black encrustation present, which is usually very small.

Once compounds have been extracted from the residue, regardless of the type, they are analyzed in a gas chromatography-mass spectrometer (GC/MS), which separates the complex mixture of compounds and produces a mass spectrum for each by fragmenting them into a distinctive sequence of molecular fragments. The mass spectrum may be identified through either a computer database search, the experience of the analyst, a literature search, or painstaking analysis of the mass spectrum to produce a tentative identification of the unknown. These compounds can also be manipulated in various ways to clarify the state of preservation and elution of compounds in the residue. Generally, a total lipid extract (TLE) is first analyzed from a sample. The TLE shows the state of the lipid components of the residue as they are extracted from the sherds and derivatized to trimethylsilyl esters in order to analyze the compounds in a GC/MS, as shown in Figure 10-2. If sufficient quantities of residue components are present in the TLE, the residue is split into neutral and fatty acid fractions. The neutral fraction includes compounds that are chemically neutral: sterols, alkanes, terpenoids, and alkanols. These components tend to be diagnostic to specific sources or types of sources, and as

such are termed “biomarkers.” For example, cholesterol is a biomarker for the presence of meat, while sitosterol (a common plant sterol) is a biomarker for the presence of plant components. Neutral compounds are the most diagnostic portion of the residue, but also the least abundant. The fatty acid fraction is comprised of all the acidic components of the residue, which are primarily fatty acids. Fatty acids are the most common component in all residues and all foodstuffs, as they are the building blocks of triacylglycerols, which make up the vast quantity of all lipids. Fatty acids are usually not biomarkers, but the ratios of the different fatty acids may indicate the types of resources processed in a vessel. Given the abundance of fatty acids, and given the fact that many different resources may have been processed in a single vessel, fatty acid ratios should be used cautiously, but are helpful in assigning a residue to a category such as “primarily plant” or “primarily meat” (Reber and Evershed 2004). The combination of TLE, neutral fraction, and fatty acid fraction allows a tolerably complete identification of the resources processed in a vessel.

Methods

All extraction procedures for absorbed residues follow the procedure developed by Evershed et al. (1990). Sherds were powdered in a solvent-washed mortar and pestle. *n*-Tetratriacontane was added as an internal standard, and the powdered sherds and standard were ultrasonicated with approximately 10 mL 2:1 v/v chloroform:methanol per 2 g of sample for 20 × 2 min with a 10 min cooling period. The resulting solvent was centrifuged at 2000 rpm for 20 min, the supernatant was pipetted into solvent-washed vials, and filtered through solvent-washed 220-440 mesh amorphous silica gel. This cleaned solvent was blown down under mild heat and N₂ gas, and stored in solvent-washed vials in a refrigerator.

Extraction procedures for visible residues follow the procedure described by Regert et al. (2003). Sampling of visible residues took place at the New York State Museum, where visible residues were scraped into clean tin foil using a clean dissection probe. Upon shipment to Wilmington, the residues were carefully transferred to a solvent-washed vial, and ultrasonicated with 5 mL of 2:1 v/v chloroform:methanol as above. All further procedures for visible residues were the same as for absorbed samples, though a smaller amount of *n*-tetratriacontane was added, as the sample sizes were much smaller for visible than for absorbed residues.

Following extraction, a portion of the residue was derivatized with approximately 200 µL *N,O*-bis(trimethylsilyl)fluoroacetamide (BSTFA) +1% trimethylchlorosilane (TMCS) to produce the TLE. About 10% of the absorbed residues were taken for TLE analysis, and about 20% of the visible residues. The TLE was analyzed

in a Fisons 8065 gas chromatograph interfaced to a Trio 1000 mass spectrometer, using a DB-1HT 15 m × .32 mm column with .1µl film thickness and with a column head pressure of 13 psi. The temperature was held at 50° for 2 min, then ramped at 10°/min until 350°, followed by a 10 min hold at that temperature. Total runtime was 42 min. Prior to analysis each day, the GC/MS was tuned with DFTPP to EPA standards to ensure consistent and precise mass spectrometry.

About 60% of the total extracted residue was transferred to solvent-washed culture tubes, then saponified with 2 mL NaOH/methanol and heated at 72° for 1 h. The saponified residues were then extracted with 3 × 2 mL hexane, which was blown down to produce the neutral fraction, which was stored under N₂ gas and refrigeration until analyzed using the same instrument and temperature program as the TLE.

The remainder of the residue, containing primarily free fatty acids, was acidified to pH 3-4 with 2 M HCl, and extracted with 3 × 2 mL hexane into cleaned culture tubes. This solution was evaporated and heated at 70-80° C (45 min) with boron trifluoride (BF₃)/methanol, then cooled and purified water (2-3 mL) added. This solution was extracted with diethyl ether (2 × 3 mL) which was evaporated to dryness. The resulting fatty acid methyl ethers (FAMES) were stored under N₂ and refrigerated until analyzed using the same instrument and column as the TLE, but with a temperature program ramping from 50-150° C at 15°C min⁻¹, followed by 150-250° C at 3° C min⁻¹, and a 10 min hold at 250° C.

Blanks were run in parallel with each batch of processed residues of both types, to guarantee that laboratory contamination was controlled for and identified if it occurred. Samples of known contaminants, such as glue and whiteout, were also analyzed using the same procedure to help in their identification.

Results

The mass of data from a large residue study can be unwieldy and hard to report in a readable fashion. Table 10-2 describes basic residue interpretations, as well as comments. The majority of the analyzed residues suggested that the pottery was used to process a mixture of resources—meat, plant, and tree resin. The high incidence of tree resin in both absorbed and visible residues from this project is taken to suggest that pottery from the region was commonly sealed with pine resin to make it more waterproof (see Reber and Hart 2008). Of the 20 separate visible residues from the site, two (10%) were uninterpretable, three (15%) were primarily plant, two (10%) were plant and tree resin, six (30%) were plant, meat, tree resin mixtures, two (10%) were meat, plant mixtures, one (5%) was a plant, meat mixture, and four (20%) contained unusual compounds and biomarkers.

Table 10-2. Residue type, interpretation, and comments on all residues analyzed in this study, both absorbed and visible.

Sherd #	Residue Type	Interpretation	Comments
Felix 40677-9	Absorbed	Plant, meat, tree resin mixture	Resin from <i>Pinus</i> sp.
Felix 40701-21a	Visible	Uninterpretable	No neutrals, fatty acids uninterpretable
Felix 40701-21b	Visible	Uninterpretable	No neutrals, fatty acids uninterpretable
Felix 40727-19a	Visible	Plant/Tree resin	Long-chain alcohols, sitosterol, and dehydroabietic acid
Felix 40727-19b	Visible	Tree resin, plant, meat, possible bitumen or tar?	Didehydroabietic and dehydroabietic acids, tris-Norhopane
Felix 40788-3	Absorbed	Plant/Tree resin	Dehydroabietic acid
Felix 40788-3	Visible	Plant, meat, tree resin mixture	Long-chain alcohols, dehydroabietic acid, and cholesterol present
Fortin 2 46238-16	Absorbed	Tree resin, possible meat mixture	Didehydroabietic, dehydroabietic, isopimaric acids and unknown diterpenoid
Fortin 2 46238-16	Visible	Primarily plant	No biomarkers; interpretation based on presence of alkanes and fatty acid abundances
Fortin 2 46238-16	Visible	Plant, meat mixture	Cholesterol, alkanes, wide-ranging fatty acids
Garoga 42826-2	Absorbed	Tree resin, possible meat mixture	Dehydroabietic, isopimaric acids, unknown diterpenoid and its methyl ester, fatty acids suggest primarily meat resources
Hunter's Home 48584-1	Absorbed	tree resin, plant/meat mixture subjected to high heat	Pyrolytic ketone series, dehydroabietic and isopimaric acids, 2 unknown diterpenoid methyl esters, fatty acids suggest primarily meat resources, some plant neutrals
Hunter's Home 48584-1	Visible	Primarily plant	Long-chain alcohol, plant-based fatty acids
Kipp Island 41119-5	Absorbed	Plant, meat, pine resin, non-pine resin mixture	Didehydroabietic, dehydroabietic, and isopimaric acids, 2 unknown diterpenoid methyl esters, cholesterol, amyirin, fatty acids suggest plant
Kipp Island 41119-5a	Visible	Primarily plant	No biomarkers; interpretation based on presence of alkanes and fatty acid abundances
Kipp Island 41119-5b	Visible	Meat, plant mixture at high heat	Cholesterol, fatty acids include ω -(<i>o</i> -alkylphenyl) octadecanoic acids, probably derived from reaction of triunsaturated C ₁₈ fatty acids
Kipp Island 41119-8a	Visible,	Plant meat; possible manure or coprolite?	Stanone/stanol series, long-chain alcohols, cholesterol, sitosterol
Kipp Island 41119-8b	Visible	Plant, meat, tree resin; possible manure or coprolite?	Stanone/stanol series, dehydroabietic and abietic acids, cholesterol, sitosterol
Klock 45738-3	Absorbed	tree resin/plant mixture subjected to high heat	Pyrolytic ketone series, didehydroabietic, dehydroabietic, and isopimaric acids, unknown diterpenoid and its methyl ester, fatty acids suggest primarily plant
Scaccia 71492	Visible	Primarily plant	No biomarkers; interpretation based on presence of alkanes and fatty acid abundances
Scaccia 71492	Visible	Uninterpretable	
Street 48217-4	Absorbed	Tree resin, possible meat mixture	Didehydroabietic and dehydroabietic acid, fatty acids suggest primarily meat, neutral compounds indicative of plants
Vinette 40031-2	Absorbed	Primarily plant	No biomarkers; interpretation based on presence of alkanes and fatty acid abundances
Vinette 40031-2	Visible	Meat, plant mixture	Cholesterol, sitosterol
Vinette 40046	Absorbed	Plant, meat, tree resin mixture	Dehydroabietic and isopimaric acids, unknown diterpenoid and its methyl ester, fatty acids indicate possibly meat
Vinette 40046a	Visible	Plant/Tree resin	Dehydroabietic acid, fatty acids suggest primarily plant
Vinette 40046b	Visible	Meat, plant mixture	Cholesterol, fatty acids suggest primarily plant
Vinette 40047-1	Visible	Primarily plant	No biomarkers; interpretation based on presence of alkanes
Vinette 40047-1	Visible	Unique non-coniferous residue	Many unidentified diterpenoids, none typical of pine or other coniferous residue
Vinette 40135a	Visible	Uninterpretable	
Vinette 40135b	Visible	Meat, plant mixture	No biomarkers; interpretation based on presence of alkanes and fatty acid abundances

continues

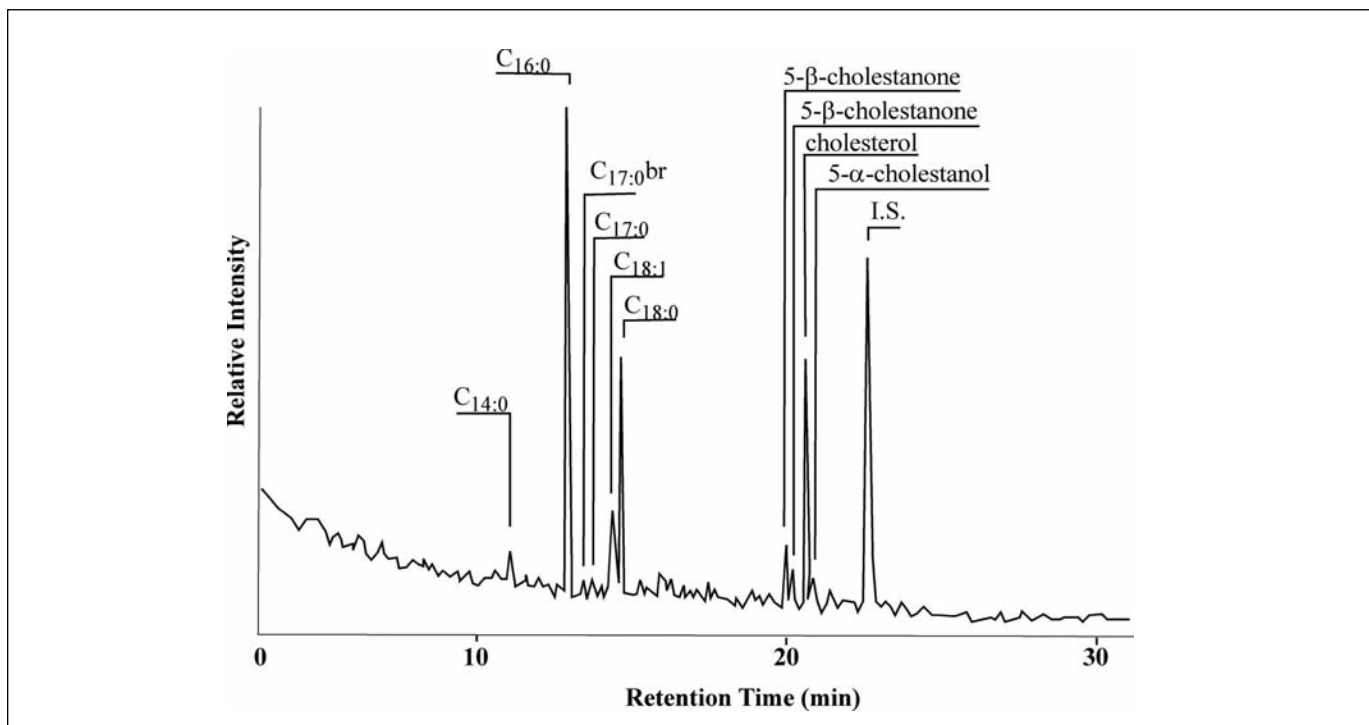
Table 10-2. Residue type, interpretation, and comments on all residues analyzed in this study, both absorbed and visible. *continued*

Sherd #	Residue Type	Interpretation	Comments
Westheimer 44533-67	Absorbed	Uninterpretable	
Westheimer 44533-67	Visible	Uninterpretable	
Wickham 40291-3	Visible	Primarily plant	No biomarkers; interpretation based on presence of long-chain alcohol, alkanes and fatty acid abundances
Wickham 40525-1	Absorbed	Primarily plant	Long-chain alcohols
Wickham 40525-1	Visible	Primarily plant	No biomarkers; interpretation based on presence of alkanes and fatty acid abundances
Wickham 40525-1	Visible	Plant, meat, tree resin mixture	Long-chain alcohols, dehydroabietic acid, cholesterol
Wickham 40525-8	Visible	Primarily plant	No biomarkers; interpretation based on presence of alkanes and fatty acid abundances

The unique visible residues included Felix 40727-19, a sample with standard tree resin, plant and meat components, as well as trisnorhopane, a triterpenoid constituent found in soils and particularly in oil and oil-byproducts, including bitumen (Connan et al. 1995; Serpico and White 2000). Given the presence of oil deposits in northwestern Pennsylvania and southwestern New York State, it is possible that bitumen was processed in, or used to seal, the pot. Also a possibility is that this component was unusually abundant in the soil at this site, and a fraction of the soil contaminated the visible residue during sampling. Another unique visible residue was Kipp Island 41119-8

(TLE shown in Figure 10-3, and neutral fraction shown in Figure 10-4). Both iterations of the sample yielded a sequence of stanols and stanones that seemed most typical of coprolites or manure (Bull et al. 2002; Bull et al. 1998; Lin et al. 1978). We are hesitant to hypothesize why this visible residue contained manure biomarkers; it is possible that the compounds are the result of either pre-historic or historic post-depositional contamination.

Kipp Island 41119-5 contained a series of isomers of the isoprenoid fatty acid ω -(*o*-alkylphenyl) tetradecanoic acid, shown in Figure 10-5. These compounds are believed to result from high-temperature reactions of triunsaturated

**Figure 10-3.** TLE of a visible residue from Kipp Island 41119-8, showing the free fatty acids present in the residue and the sterol/stanone series typical of manure or coprolites.

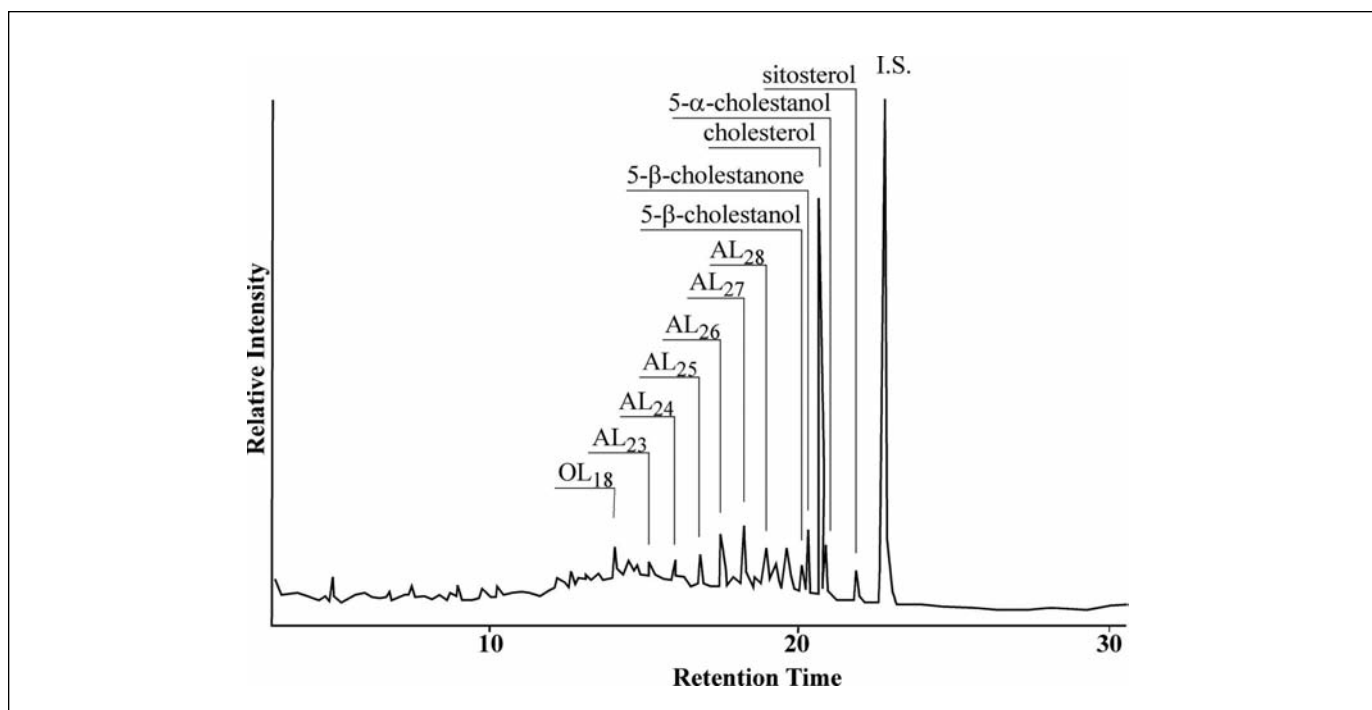


Figure 10-4. Neutral fraction of the visible residue from Kipp Island 41119-8, whose TLE is shown in Figure 3. Note that the sterol/stanone series has become clearer, more complete, and better defined, including the biomarker for plant presence, sitosterol. It is worth noting that both sitosterol and cholesterol can appear in manure, as they are not usually completely digested (Bull et al. 1998; Lin et al. 1978; Reber 2007). Long-chain alcohols are indicated by OL with the carbon number in subscript, and alkanes are indicated by AL with the carbon number in subscript.

C_{18:3} fatty acids, which are common in both fish and vegetable oils (Hansel et al. 2004). In fish oils, however, alkylphenyl fatty acids should occur with 16 and 20 total carbons, as well, which is not the case in this residue. Instead, with only 18-carbon alkylphenyl fatty acids present, the residue follows the description of the expected result from a highly unsaturated vegetable source subjected to high heat (Hansel et al. 2004). The final unique visible residue was Vinette 40047-1, which contained a series of unidentified diterpenoids completely different from anything else in the study. The compounds seemed to resemble those found in non-pine residues from plants (not trees), but the exact source of these compounds is presently unidentified. Investigations into non-pine residues from the central New York region are ongoing.

Absorbed residues from the sites showed a similar mixture of resources processed in pottery, but with a higher incidence of tree resin, probably, as mentioned above and discussed elsewhere, due to pot-sealing techniques. Of the 12 absorbed residue samples, one was uninterpretable; two were primarily plant in origin; two were interpreted as plant, meat, tree resin mixtures; one as a plant/tree resin mixture; three suggested tree resin/possible meat mixtures; and three were unique. The unique residues included Kipp Island 41119-5, a mixture of plant, meat, tree resin, and non-tree resin, indicated by

the triterpenoid amyrin. The other two absorbed residues contained pyrolytic series, which is a sequence of ketones formed by pyrolysis of common fatty acids, indicating that a residue was heated to above 300° (Evershed et al. 1995). Visible residues from the same sherds did not contain the pyrolytic series, though this may have been due to too small of a sample from the visible residues to detect the ketones, or the possibility that only the absorbed residue was exposed to high heat. If the latter were the case, it would indicate that the pots were used for a variety of purposes, some of which were high-heat, and some of which were not.

Interpretations of absorbed and visible residues were overlapping, but not identical; but probably from the result of basic differences between absorbed and visible residues. Since visible residues presumably result from one, or at least a small number, of culinary disasters, and since absorbed residues generally result from lipids absorbed over the entire use-lifetime of a vessel, it is theoretically possible that a visible and absorbed residue from the same vessel could be completely different. The visible residue could potentially be from a single, atypical meal, while the absorbed residue would reflect the entire use-lifetime of the pot, which could extend over a period of years. Much more likely, of course, is that a visible residue would result from a typical meal that was burned;

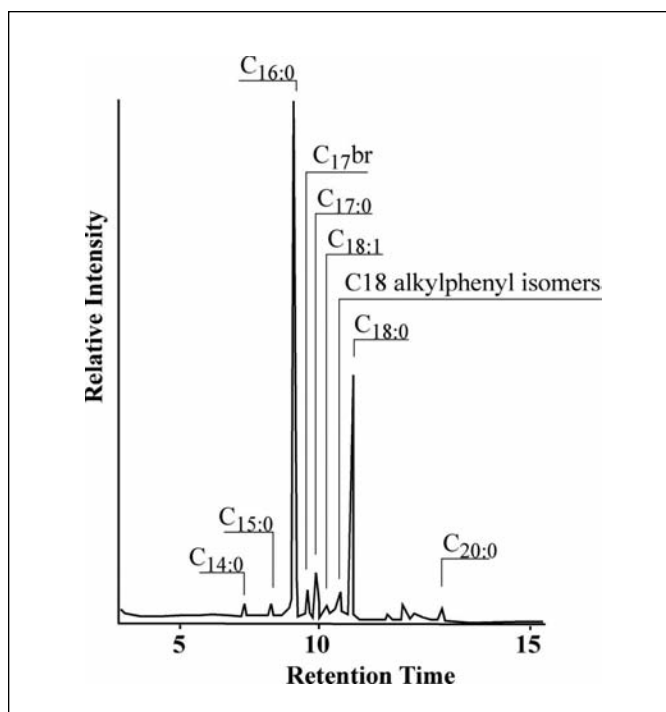


Figure 10-5. Fatty acid methyl ester (FAME) fraction from a visible residue extracted from Kipp Island 41119-5, showing the 18-carbon isoprenoid fatty acids, typical of heat-caused reactions of triunsaturated fatty acids. Since the only isoprenoid fatty acids present in this residue have 18 carbons, it seems likely that the polyunsaturated fatty acids originate from vegetable oils, rather than fish oils.

however, even a typical meal is unlikely to be identical to the lipids absorbed in a vessel over a period of years or months. In this project, tree resins seem to have been commonly absorbed into pots, as shown in the absorbed residues, but were much less likely to be present in visible residues. This could be simply a statistical artifact of vessel use history. Alternately, it could reflect the fact that pots used for resin processing may have been less likely to char or burn, either because resin burns at a very high temperature, or because people were watching the vessels more carefully when they contained resin than when they contained foodstuffs.

DISCUSSION AND CONCLUSIONS

Although further analysis of more residues will need to be performed on samples from central New York state, absorbed and visible residue analysis does indicate some of the ways in which pottery was utilized in this area. Pottery seems to have been used to process a wide range of resources, including both plant and meat resources, with plant-based resources predominating. The residues from many of the pots tested (12 of the total of 20) indi-

cated that the pots probably had been subjected to some sort of sealing process or used to process tree resin. At least three of the residues had been subjected to high heat, indicating that pots were used in high-heat applications at least occasionally. High-heat would imply much higher temperature than used by simple boiling or stewing; either frying, roasting, toasting, or some sort of use as a fire carrier are indicated by the pyrolytic formations of ketones and the heat-based formation of alkylphenylalkanoic acids mentioned above. The overall portrait of pottery use that can be discerned from this relatively small study suggests that pottery was used for a range of resources and a range of uses.

This range of uses may have included maize processing; the technique for detection of maize in lipid residues requires a large amount of maize to have been processed in a vessel for it to be detectable in absorbed or visible residues. Small, or even moderate, amounts of maize could have been prepared in the pots from which the sherds tested in this study originated but not be detectable at the present time. For this reason, although maize was not a primary food resource, it may easily have been one of the range of resources processed in the analyzed vessels as indicated by the results of phytolith analyses (Hart et al. 2007a).

Moreover, the high yield of information from visible residues (only 5 of 38 samples were uninterpretable) demonstrates the usefulness of visible residue analysis of common pottery. If visible residues are present on potsherds, the odds are better than 50% that useful information can be derived from that residue. Given the non-destructiveness of visible residue analysis compared to absorbed residue analysis, excavators should seriously consider submitting visible residues for further examination.

Residue analysis has great potential in analyzing the real uses of pottery vessels; it is therefore unique both in stylistic analysis and in pottery use analysis. Moreover, particularly when paired with other microbotanical analyses such as phytolith and starch analyses of visible residues, as was done in this project, residue analysis allows a unique window into ancient resources processed in pottery.

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CHAPTER 11

CHRONOLOGY AND EVOLUTION OF THE GREEN POINT FLOOD PLAIN AND ASSOCIATED *CUCURBITA PEPO*

by William A. Lovis and G. William Monaghan

In our continuing research into the changing economies of the Saginaw Bay area of Michigan, we will address a series of questions regarding the on-site and off-site contexts of directly dated squash remains from the Green Point vicinity along the Saginaw River (Figure 11-1b). Further, we will discuss what the contextual and age relationships of these seeds reveal about the strategies by which wild and domesticated *Cucurbita* were incorporated into existing hunter-gatherer settlement and subsistence strategies. In particular, we focus on the age and stratigraphic relationship of uncarbonized squash seeds discovered at two different off-site locations adjacent to the Green Point site (20SA1), which is one of two significant stratified sites in this location (Monaghan et al. 2006; Wright 1964; Figures 11-1b, 11-3a and 11-3b). While the seeds from these two locations occur in similar environmental contexts, their ^{14}C ages are quite different. Our goal in this paper is to understand the cultural and natural circumstances under which the seeds occurred, the implications that these contexts have for understanding long-term stability in certain aspects of local subsistence systems, as well as how these data should influence archaeological research methods. As we have used in previous presentations we employ the term “gourd” as a referent for undomesticated, wild varieties of *Cucurbita* that usually have small, bitter (inedible) fleshed fruits, and the term “squash” for domesticated varieties with edible flesh or seeds. All AMS and conventional ^{14}C date ranges are presented as B.P., calibrated at two sigma (cal. 2 σ) intervals. Culture historic time periods and general ages not referencing specific radiometric dates are presented without calibration as B.P.

The older of the two direct dates, 2820 \pm 40 B.P. (cal. 2 σ 3064–2844 B.P.), derives from an uncarbonized seed that was buried 2–3 m deep in alluvial and wetland deposits along the Saginaw River, at Green Point near Saginaw Bay (Monaghan et al. 2006; Figures 1b, 3a and 3b). The

younger of the directly dated seeds, 1830 \pm 40 B.P. (cal. 2 σ 1871–1693 B.P.; Table 1), also derived from a similar deep alluvial and wetland context, and its age is reported here for the first time. Significantly, these seeds were found in two different off-site areas of the Green Point locale, during different research projects separated by nearly 40 years. The recent direct AMS dates on two of the two sets of seeds suggest that the wetland adjacent to Green Point was long-lived, and that squash seeds were deposited as flood detritus likely carried from either naturalized stands of squash or tended gardens on the floodplain (Monaghan et al. 2006). Furthermore, the AMS dates reveal that this wetland formed before cal. 3000 B.P., and that significant portions were subsequently buried by alluvial accretion between cal. 1500 and 2000 B.P. (Lovis et al. 2001). These two observations have important implications for understanding both the timing and evolution of the floodplain sequence, as well as how local populations may have used or altered the local floodplain ecology during the late Holocene.

THE REGIONAL BACKGROUND

The antiquity of *Cucurbita* use by indigenous populations in eastern North America has been repeatedly confirmed by direct AMS dating of squash and gourd parts from many archaeological sites. These data demonstrate that *Cucurbita* have been used in the eastern U.S. since at least 7000 B.P. (see Hart, this volume, for a recent summary). Squash is a southern plant that was domesticated in two places: first, in southern Mexico about 10,000–9000 B.P. and then independently in the lower Mississippi River valley ca. 4500–4000 B.P. (Decker-Walters et al. 1993; Smith 1992, 1995, 1997, 2000). These later examples are probably the types grown by Archaic (10,000–2500 B.P.) and Woodland (2500 B.P. to contact) peoples of North America.

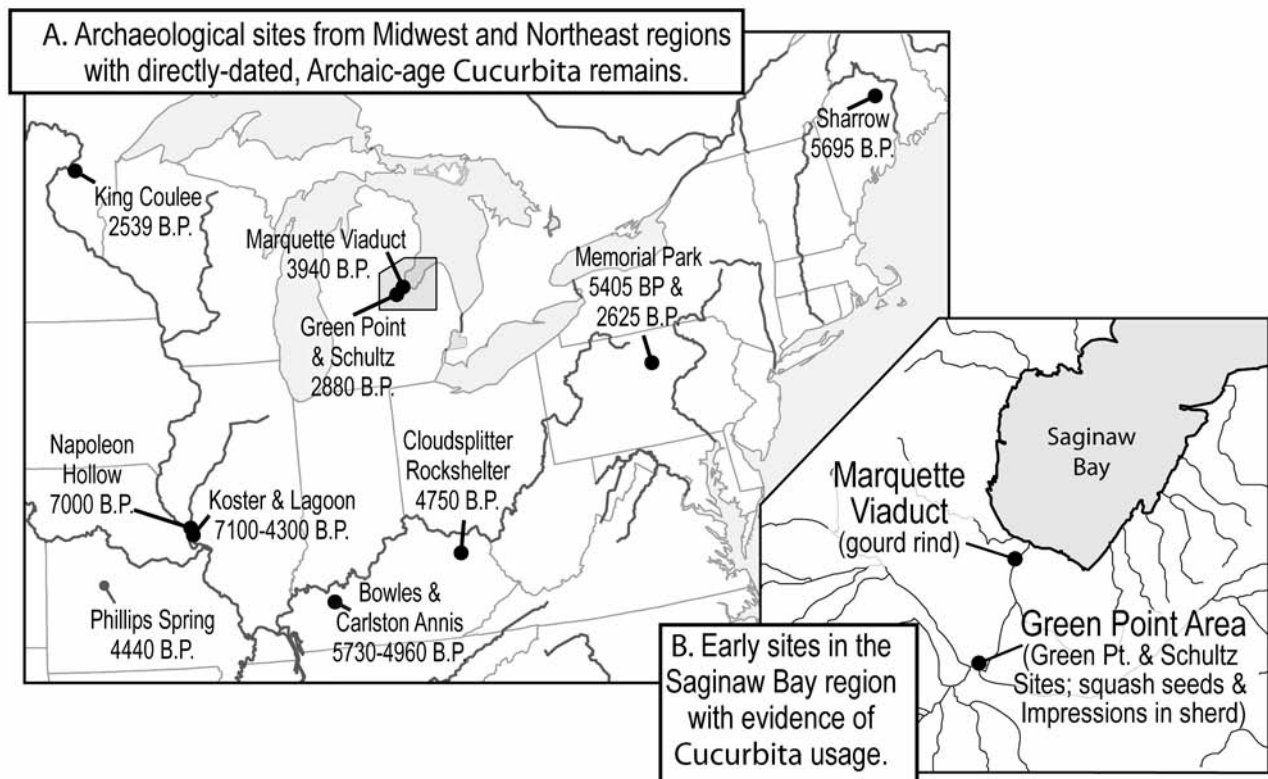


Figure 11-1. Locations of Archaic archaeological sites with *Cucurbita* remains in the midwest and northeast U.S., and early sites in the Saginaw Bay region, Michigan. (Reproduced courtesy of Glenn A. Black Laboratory of Archaeology, Indiana University)

- Archaic-age archaeological sites from midwest and northeast U.S. regions with directly-dated *Cucurbita* remains. (Uncalibrated radiocarbon years before present; after Monaghan et al. 2006.)
- Early sites in the Saginaw Bay region with evidence of *Cucurbita* usage.

The earliest gourds in the eastern and midwestern U.S. (Figure 11-1a) are found at sites in the Illinois River valley, such as Koster and Napoleon Hollow, ca. 7000 B.P. (Conard et al. 1984; Cowan and Smith 1993; see Newsom 1994; Newsom et al. 1993, 2002; and Newsom and Muhlbachler 2006 for southeastern examples). By ca. 5000 B.P. gourds had spread to sites in the Ohio Valley, the Appalachian Plateau (Hart and Asch Sidell 1997), and eastward as far as the Sharrow site in coastal Maine (Petersen and Asch Sidell 1996; Figure 11-1a). In the upper Great Lakes, the focus of this paper, *Cucurbita* was present by about cal. 4500–4200 B.P. (Monaghan et al. 2006). *Cucurbita* from these early sites were probably gourds, but squash is definitely found in the lower Mississippi and Ohio Valleys and its tributaries (Chomko and Crawford 1978) by the end of the mid-Holocene. At sites such as Phillip Springs and Cloudsplitter Rockshelter (Figure 11-1a), the processes of domestication can be traced through the post-5000 B.P. occupation horizons. By 4000 B.P. sufficient morphological changes in seeds and rinds had occurred to clearly distinguish between gourds and their domestic squash counterparts.

These large-seeded squashes soon spread throughout the Northeast; directly dated examples have been reported from as far east as the Appalachian Plateau and north and west to the upper Great Lakes and upper Mississippi Valley of Minnesota (Figure 11-1a). This dispersion was probably through down-the-line exchange mechanisms (Kay et al. 1980). Importantly, squash at these more northern archaeological sites are nearly as early as the earliest domesticated plants from the lower Mississippi River valley, and provide important clues about both the timing of squash evolution, and how newly introduced crops became incorporated into settlement and subsistence systems. As noted below, the context of the squash seeds from the Green Point vicinity in Michigan also reveals a pattern to early plant management and horticultural practices.

CUCURBITA IN THE UPPER GREAT LAKES

Early gourd and squash remains in the upper Great Lakes region derive from two locales in Michigan, both of which

Table 11-1. Key archaeological sites, finds of *Cucurbita*, and pertinent radiocarbon dates from the Saginaw Valley, Michigan

Marquette Viaduct Site/20BY387			
Beta-181524 (carbonized <i>Cucurbita</i> rind)	3940±40 B.P.	cal 2σ 4516–4248 B.P. (1.0 relative area)	(Monaghan et al. 2006)
Green Point Site Early Woodland Occupation/20SA1			
Beta-150203 (uncarbonized squash seed)	2820±40 B.P.	cal 2σ 3064–2844 B.P. (.98 relative area)	(Monaghan and Lovis 2005)
M-1432 (nut charcoal)	2480±120 B.P.	cal 2σ 2796–2307 B.P. (.99 relative area)	(Wright 1964)
Pooled Mean	2796±38 B.P.	(t=7.23, df=1; different at 95%)	
Green Point Site Middle Woodland Occupation/20SA1			
Beta-215173 (1962 uncarbonized squash seed)	1830±40 B.P.	cal 2σ 1871–1693 B.P. (.97 relative area)	(this paper)
Beta-150262 (2000 feature)	1830±40 B.P.	cal 2σ 1871–1693 B.P. (.97 relative area)	(Monaghan et al. 2006)
Schultz Site Early Woodland Occupation/20SA2			
M-1524 (charcoal)	2490±130 B.P.	cal 2σ 2852–2306 B.P. (.99 relative area)	(Crane and Griffin 1966)
M-1525 (charcoal)	2480±150 B.P.	cal 2σ 2867–2292 B.P. (.94 relative area)	(Crane and Griffin 1966)
Pooled mean	2486±98 B.P. (t=.002, df=1; identical at 95%)		
Pooled mean (w/M-1432)	2483±76 B.P. (t=.004, df=2; identical at 95%)		

Note: All calibration, pooled means, tests for contemporaneity and significance calculated with modules in Calib 5.0.1 and IntCal04 (Reimer et al. 2004; Stuiver and Reimer 1993; Stuiver et al. 2005).

occur in the Saginaw Bay region of Lake Huron. The earliest evidence is a 3940±40 B.P. (cal. 2σ 4516–4248 B.P.) carbonized rind found within a cultural feature at the Marquette Viaduct site (20BY387) in Bay City, while younger seeds dated to 2820±40 B.P. (cal. 2σ 3064–2844 B.P.) have been reported from the Green Point area, about 20 km upstream from Bay City, near Saginaw (Monaghan et al. 2006; Table 11-1, Figures 11-1b, 11-3a and 11-3b).

The older *Cucurbita* rind from the Marquette Viaduct site (20BY387; Lovis 2002) in Bay City, Michigan (Figure 11-2a) is too small to identify to variety and is also, using standard thickness criteria, too thin-walled to be called a squash (i.e., domesticated *Cucurbita*; Cowan 1997; Fritz 1997; King 1985). That said, the presence of any *Cucurbita* so far north at this time is intriguing, and has implications for the structure of exchange networks, the influence of Hypsithermal climate change, and other roles that humans may have played in spreading wild, southern plants into more northern regions. However, the younger, clearly domesticated squash seeds from the Green Point area, and their context at or near archaeological sites, are the focus of the remainder of this discussion.

Squash from the Green Point (20SA1) and Schultz (20SA2) Sites

The Green Point area of Michigan includes two variably stratified, multi-component sites: a mainly Woodland period occupation at the Schultz site dated ca. 2500–800 B.P. (Green Point I site, 20SA2; Fitting 1972; Lovis et al. 2001; Ozker 1982), and what has been described as Terminal Archaic through Middle Woodland (ca. 2600–1600 B.P.) occupations at the Green Point site (Green Point II site, 20SA1; Wright 1964; Figures 11-1b, 11-3a and

11-3b). Squash remains, including seeds, have been found at or near both sites in dated cultural contexts that span the Late Archaic through Middle Woodland periods.

For example, a squash seed impression was identified on an Early Woodland (ca. 2600–2200 B.P.) Schultz Thick ceramic fragment collected from the Schultz site during an early 1960s excavation (Ozker 1982; Ford 1973, 1989; Figure 11-2b). Schultz Thick pottery at the Schultz site, and elsewhere, generally dates to cal. 2852–2292 B.P. Two conventional charcoal dates on the Schultz site Early Woodland occupation are statistically identical at 95%, with a pooled mean age of 2486±98 B.P. (cal. 2σ 2752–2348 B.P.; Table 11-1). The detail of this negative seed impression is remarkable and allowed Ford (1989) to suggest that it represented *Cucurbita pepo* ssp. *ovifera*, although if based on its small size (ca. 8 mm long) it may not represent a squash, i.e. it may not be a domesticated variety.

Uncarbonized squash seeds were recovered from areas adjacent to the Green Point site by different institutions during two separate field projects four decades apart. Notably, these seeds all derived from non-cultural, off-site wetland deposits rather than from direct cultural contexts as expressed by material culture or culture features (Monaghan et al. 2006; Wright 1964). The fact that they are squash seeds, however, indicates that regardless of the context of their discovery, their ultimate derivation is cultural.

The first reported examples of seeds in such context at Green Point were two uncarbonized seeds of *Cucurbita pepo* (Figure 11-3c) discovered during a 1962 University of Michigan Museum of Anthropology excavation at Green Point by Henry Wright and subsequently reported by him (Wright 1964). These seeds, identified as *Cucurbita pepo* by

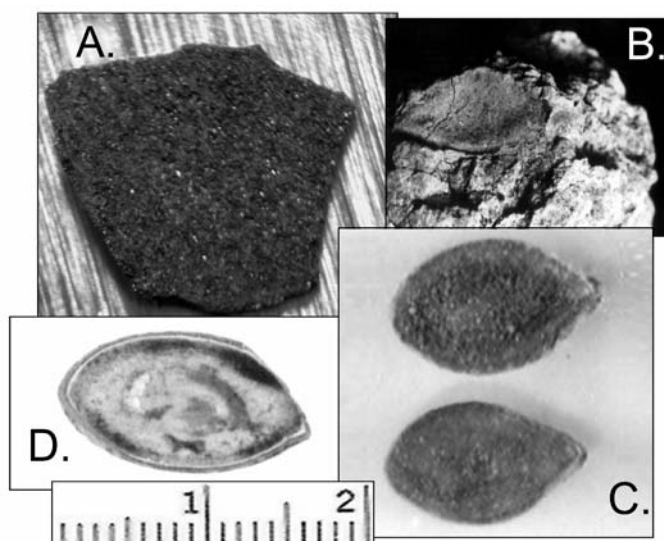


Figure 11-2. *Cucurbita* (squash and gourds) from the Saginaw Valley discussed in the text.

- a. *Cucurbita* gourd rind from Marquette Viaduct site (20BY387), Bay City, Michigan after sampling, 2.7 x 3.2mm; <2mm thick; 2.7 x 4 mm when intact prior to sampling (Photo by Gerald Urquhart)
- b. *C. pepo* ssp. *ovifera* seed impression in Early Woodland sherd from the Schultz site (20SA2). (UMMA68802, reproduced with permission of the University of Michigan, Museum of Anthropology)
- c. Uncarbonized *C. pepo* seeds from Green Point II site (20SA1) recovered in 1962. (Reproduced with permission of the University of Michigan, Museum of Anthropology)
- d. Uncarbonized *C. pepo* seed from Green Point II site (20SA1) recovered in 2000.

Volney Jones (Wright 1964), were found on the Saginaw River floodplain about 50 m off-site buried 2 m deep in organic-rich alluvial deposits. The seeds were considered to be Transitional Archaic in age because their off-site stratigraphic horizon could be correlated with an aceramic, and therefore presumably Archaic, ^{14}C dated occupation horizon at 20SA1 (Wright 1964). "Transitional" in this context suggests the boundary with the Early Woodland period, perhaps as early as ca. 2800 B.P. As has become increasingly evident through statistical reanalysis, however, the conventional ^{14}C age of this occupation is identical to the two dates from the adjacent Schultz site Early Woodland occupation (Ozker 1982; Speth 1972; Table 11-1), and suggests that the occupation at Green Point is an aceramic and spatially discontinuous component of the Early Woodland occupation at the Schultz site. The two uncarbonized seeds discovered by Wright were substantially larger (ca. 13 x 8 mm in size) than the seed impressions in the Early Woodland pottery recovered from the adjacent Schultz site, and meet the standard criteria as squash.

Regardless of their size, stratigraphic position, or domesticated origins, a recently obtained AMS date on

one of the original Archaic-age seeds reported by Wright (1964) from Green Point yielded a ^{14}C age of 1830 \pm 40 B.P. (Table 11-1), demonstrating that they are related to neither the Archaic nor Early Woodland occupations at the nearby sites, but rather that they are likely associated with a Middle Woodland occupation. This age disparity raises clear questions about the age of the Green Point floodplain, the duration of its development, and the relationship of uncarbonized squash from these contexts to the adjacent occupations.

More recently, while deep testing an area just north of the main Green Point site area in 2000, another uncarbonized squash seed was discovered similarly buried in wetland deposits under about 3 m of alluvium (Figure 11-3d; Demeter et al. 2000; Monaghan and Lovis 2005). This seed is even larger than those reported by Wright (1964), about 16 x 9 mm, and clearly derived from a domesticated *Cucurbita pepo*, either subspecies *ovifera* or subspecies *pepo* depending on which expert one consults and where they place morphological primacy in terms of metric and/or discrete characteristics (Monaghan et al. 2006). AMS dating of this seed yielded a ^{14}C age of 2820 \pm 40 B.P. (cal. 2 σ 3064–2844 B.P.; Table 11-1), which is Late Archaic, clearly earlier than any dated Early Woodland ceramic context in the region, and most critically, also statistically earlier than (and therefore not contemporary with) any of the three Early Woodland dates from either the Green Point or Schultz sites or with the seeds reported by Wright (1964) from the area (Table 11-1). The off-site context of both the Late Archaic and Middle Woodland seed discoveries is crucial to our understanding of the way in which squash was incorporated into local economic and scheduling systems, and provides important clues about their derivation as well as their cultural and chronological significance.

The fact that uncarbonized seeds were preserved within the Green Point alluvial sequence suggests that the floodplain surface was continually saturated, rapidly buried, and likely formed a riverine wetland. A reconstruction of the stratigraphic and depositional contexts of sediments related to the origin and burial of the 2800 B.P. seed (Figure 11-3c) shows that the floodplain near Green Point must have been stabilized about 3 m below present prior to about cal. 3000 B.P. The accretion of the floodplain apparently began sometime after about cal. 2800 B.P., during the Transitional Archaic or Early Woodland occupation of the Green Point and Schultz sites and was probably rapid. The presence of a Middle Woodland-age cultural feature, which was buried about 50 cm deep in the alluvium and dated to 1830 \pm 40 B.P. (cal. 2 σ 1871–1651 B.P.; Figure 11-3c; Table 11-1), indicates that the majority of alluviation probably ended by about this time. The date of this feature is particularly interesting because it is identical to the radiocarbon age obtained from the other,

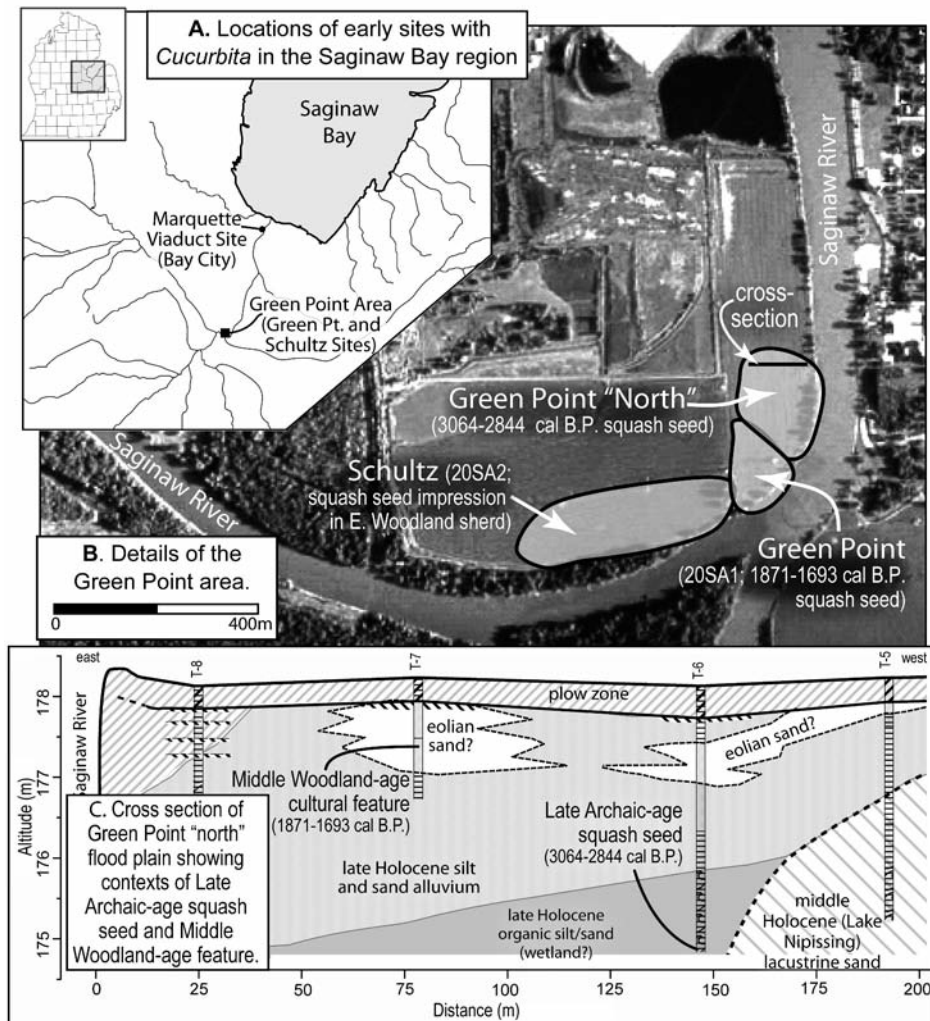


Figure 11-3. The Green Point area and reconstructed stratigraphy of the Green Point floodplain. (Reproduced courtesy of Glenn A. Black Laboratory of Archaeology, Indiana University)

- Locations of early sites with *Cucurbita* in the Saginaw Bay region, Michigan.
- Details of the Green Point area, Saginaw, Michigan.
- Cross section of Green Point "north" flood plain showing contexts of Late Archaic-age squash seed and Middle Woodland-age feature. (See Table 11-1 for radiocarbon dates; after Monaghan and Lovis 2005.)

uncarbonized, squash seed from Green Point, discovered 40 years ago by Wright (1964; Table 11-1).

The Middle Woodland age of both the feature mentioned above and that of these seeds, and the fact that the seeds were buried by over 2 m of sediment all support the notion that sedimentation was rapid and probably concentrated after about cal. 2000 B.P. Moreover, Middle Woodland squash seed and rind remains were reported by Lovis et al. (2001) within similar age alluvial deposits at the adjacent Schultz site. While not the primary focus of this presentation, rapid, extensive sedimentation between cal. 2000 and 1500 B.P. has been described by both us (Lovis et al. 2001) as well as others (Speth 1972) at the Schultz site, and was probably caused by a 2–3m basin

wide transgression of Lakes Huron and Michigan that we have described elsewhere (Monaghan and Lovis 2005).

To summarize, the Green Point vicinity (NOT the Green Point site 20SA1 proper), and the Schultz site have produced the following chronological sequence of squash remains (Table 1):

- a single uncarbonized *C. pepo* seed from 3m deep, off-site, floodplain contexts dated to at least cal. 2844 B.P.;
- a negative squash seed impression of *C. pepo* var. *ovifera* from Early Woodland occupations at the Schultz site 20SA2, which has a pooled mean age on two ^{14}C dates of cal. 2486 B.P., that is statistically

contemporary with the dated aceramic occupation at the Green Point site 20SA1; and

- (3) uncarbonized seeds of *C. pepo* from 2 m deep, off-site, floodplain contexts, as well as a cultural feature from 20SA1, that are identically dated to cal. 2σ 1871–1693 B.P., and falling within the age range of squash rind recovered from features at 20SA2 (see Lovis et al. 2001; note that all Middle Woodland dates from the Schultz site [M-1525, Beta-66989, M-1644, Beta-66990, M-1646, M-1647] are statistically identical at 95% including the two dates reported here).

DISCUSSION OF SEED CONTEXTS

While the direct AMS dates of these seeds refute Wright's original assertion that the squash seeds found in 1962 were related to the Late Archaic occupation, he correctly anticipated that seeds of such age existed in the Green Point vicinity. The context of these buried seeds sheds light on several important factors concerning how wetlands relate to early food production in the region, as well as the long-term continuity of methods of food production across multiple cultural periods. The 1,000-year difference in age between the two sets of uncarbonized, domesticated seeds buried within the wetland sequence is important for contextualizing the cultural and natural processes responsible for their presence and their burial within the sequence.

First, in the Saginaw Bay region squash remains have been found nearly as often in non-cultural, wetland deposits from off-site contexts as in cultural deposits on archaeological sites. That these seeds were found at all, let alone in different places and at different times, indicates that squash seeds are likely abundant and even ubiquitous in the sequence. Furthermore, their uncarbonized occurrence in an alluvial sequence implies that squash plants must have been common on the landscape surrounding the site, and likely grew in naturalized or marginally tended beds or stands (Monaghan et al. 2006). We also acknowledge the potential use of *Cucurbita* as fish net floats (Hart et al. 2004). This is a practice that is more likely with gourds, and may result in seed deposition in riverine floodplain and wetland contexts. It is unlikely that economically important, large seeded, edible squashes were employed for this purpose. Regardless, the relative abundance of uncarbonized seeds is further attested by the fact that neither discovery came through the application of flotation recovery procedures commonly applied to occupation areas. While they were all recovered from non-cultural, organic-rich alluvium, which makes them part of a natural rather than cultural depositional sequence, morphologically the seeds derived from

squash that must have been at least managed, if not planted by local populations. This is suggested because the probability of seeds being exchanged to the site, and then lost, and then buried in alluvium, without any also present at the adjacent occupation site is quite small. Clearly, some effort must have been expended by the local population to grow the squash, and it was sufficiently abundant on the landscape to become incorporated into the sedimentary record in an uncarbonized state.

As others have noted (e.g., Asch and Asch 1985a; Conard et al. 1984; King 1985; and see Smith 1987, 1992 for a summary), various gourds and squashes have the ability to both self-propagate and naturalize over large areas, and particularly in disturbed soil conditions. This adaptive ability makes them particularly suitable to propagation in disturbed soils in natural situations such as floodplains, and anthropogenic soils in occupation sites, which has fostered its inclusion with indigenous seed plants in so-called floodplain hypotheses for early plant domestication in eastern North America (Smith 1992).

In an early discussion of the floodplain hypothesis Smith focuses on and expands an important point made by Asch and Asch (1985), and pertinent to the current discussion of squash remains from northern sites such as Green Point:

... Asch and Asch remark on the pronounced self-propagating ability of *C. pepo* var. *ovifera* (Conard et al. 1984; Asch and Asch 1985a:157), but they argue that, unlike the bottle gourd, it could not have persisted prehistorically without "at least occasional replanting by Indians" (1985a:158). While this need for occasional replanting may be true for more northern latitudes ... (Smith 1987:22)

The Green Point data presented above suggest that Archaic, and Early and Middle Woodland-age *Cucurbita* most likely derive from open, and regularly disturbed, floodplain stands. As the earliest and most northern true squash identified macrobotanically in eastern North America to date they also conform closely to the qualifications of Asch and Asch, and of Smith, i.e., they were probably occasionally and in our view probably regularly replanted or tended by local populations. Considering their additional propensity to revert rapidly to their more dominant bitter state if not properly pollinated by other domestic varieties, i.e., cross pollination (see Hart, this volume and 2004), there are multiple reasons for regular and even essential human intervention and maintenance of floodplain squash stands in the Saginaw basin.

Given these assumptions and observations, the fact that clearly domesticated squash seeds, dating 1,000 years apart, were recovered from such wetland contexts implies some continuity in squash usage and associated squash

horticultural practices from Late Archaic hunter-gatherers through at least Middle Woodland adaptations that relied on more intensive collection of indigenous starchy and oily seeds. Moreover, parallels are clearly evident between the Green Point seed contexts and those at the Phillip Springs site where uncarbonized seed assemblages were also common (Kay et al. 1980), as well as the more general notions associated with the mud flat horticulture hypothesis initially posed by Struever and Vickery (1973, but see Smith's 1992 critique). While beyond the scope of this chapter, the final iteration of such floodplain garden-bed systems may be the floodplain wetland-situated, ridged field infrastructures of Oneota and other late pre-Contact upper Great Lakes societies.

The Green Point data show that the pattern of squash management we describe was in place about cal. 3000 B.P. and that Late Archaic hunter-gatherers managed domesticated squash in naturalized or informal contexts. Ethnographic data reveals that the initial implementation of horticultural practices and the informal management of domesticated plants can be accommodated with little alteration of hunter-gatherer subsistence and settlement systems and the scheduling of resource use. For example, one can invoke the rather pragmatic use of gardens by the Mbuti of West Africa, as described by Turnbull (1962) or Raymond and DeBoer's (2006) use of ethonographic analogs to elucidate the processes involved in maize adoption and transmission. While such a pattern is clearly consistent with Archaic hunter-gatherer subsistence and social systems, its success during the Late Archaic may have as much to do with the ease by which squash can naturalize on the landscape rather than as a general principle. That said, this form of squash "horticulture" as evidenced in the Saginaw Bay region of Michigan, which likely involved organic and hence nutrient-rich alluvial locations, was apparently also practiced by local Middle Woodland societies engaged in the more intensive collection of indigenous starchy and oily seeds associated with the Eastern Agricultural Complex (Lovis et al. 2001). It was apparently a successful enough strategy to continue for at least a millennium or more after its Late Archaic beginnings.

SITE, LOCALE, AND LANDSCAPE: METHODOLOGICAL IMPLICATIONS

The context of the *C. pepo* seeds in non-cultural deposits near sites in Michigan is significant from the vantage point of archaeological method. These data imply that naturalized or informal stands of domesticated squash were likely managed in beds proximal to habitation sites rather than only in intensively cultivated gardens within main areas of occupation, or even in the soils that such

occupations enrich and modify (anthrosols, disturbed anthropogenic environments, or domestilocalities *sensu* Smith 1987, 1989). This observation begs the long-standing questions of just what a site is, and how or even if we should define its limits. While the Green Point data cannot provide comprehensive answers to these issues, if they are indeed answerable, they do provide some insights into the concept of site and its application in regional research.

For example, the Green Point data imply that informal gardens or semi-naturalized squash stands presumably occurred away from but close to the actual Archaic and Woodland occupation areas, which is usually defined by debris and feature scatters and is what we typically think of as a site (see also Yellen's [1977] absolute limit of scatter [ALS] in an ethnoarchaeological context). Such spatial distribution of broader activity areas within a larger (and some would argue human modified) landscape has some important implications for how we "do" archaeology and underscores the interplay between scalar concepts of *site*, *locale* and *landscape* (see Lovis 2008 for a local level discussion of regional Archaic locales; Rossignol and Wandsnider 1992 on landscapes) as well as how they should be sampled and studied. As we hope the case study used here has demonstrated (and recognizing that this is a topic already familiar to many readers), the complexity of these relationships means that effective archaeological research should be multi-disciplinary in structure and incorporate stratigraphy, depositional sequences, taphonomy and geochronology of both *cultural* and *non-cultural* deposits at a spatial scale larger than the site. Furthermore, the common notion of "site" should be systematically expanded to incorporate adjacent or nearby "off-site" areas that may lack cultural debris reflecting human use.¹ In this instance, for example, the areas of Green Point producing non-carbonized squash seeds lacked the standard material indicators of occupation; ceramics, lithics, bone, and other material debris.

As this and other aspects of our regional research in the Saginaw Bay region of Michigan reveals, certain types of physiographic features, and feature or landform complexes, are clearly preferred for human occupation, and often over extended periods of time. Green Point, which lies at the confluence of several river tributaries and is surrounded by expansive wetlands, includes occupations that span the Late Archaic through the contact period, is a clear example of this predilection. Likewise, overlapping sets of occupations near the mouth of the Saginaw River in Bay City, where the gourd rind from Marquette Viaduct was discovered, also reveals similar long-term and repetitive use over a comparable time span (Lovis 2008; Lovis et al. 2001). These types of overlapping occupations with substantial spatial disparities in the frequency of material debris and the intensity of human use are

what have locally been termed “locales” (Lovis 2008) and often reveal evidence that they were subject to provisioning for future use (Lovis et al. 2005). Others have coined and employed the term “persistent place” to accommodate the social value attached to their location and their regularity of use (Schlanger 1992; but see Barton et al. 1995 for a Mesolithic hunter-gatherer case study). To call a several-kilometer-long linear array of occupations spanning three millennia a single “site” begs the question of what we are defining as the unit of analysis. To expect all behaviors associated with those occupations to be constrained within an area of material scatter is untenable.

Focusing on the *cultural landscape* represented by these different areas of cultural use may be a more productive way of studying even seemingly simply structured early sites, or segments of larger locales. Here, we find ourselves in agreement with various epistemological facets of either so-called non-site archaeology (Thomas 1975), or what has been termed Distributional Archaeology (Ebert 1992), albeit in low visibility, often heavily developed, and complex stratigraphic contexts.

Finally, we firmly believe that our recent work on the Green Point locale demonstrates that organic material and other sediment should be systemically collected and processed from all components of the larger surrounding *cultural landscape*. These data are critical in order to reach a more complete understanding of the record of crop histories, their relationship to changing human settlement and land use, and the evolution of subsistence economies across multiple cultural periods within a region. While expensive and time consuming, our work demonstrates that effective archaeological research must continue to apply intensive, fine-scale recovery methods to both cultural and non-cultural (read off-site) deposits. Even more so, our experience once again shows that critical samples of early crops should be subject to direct AMS dating regardless of cultural context, however obvious that context may seemingly be. This begs the directed but also systematic and judicious use of carefully curated museum collections for such purposes (Hart et al. 2003; Lovis 1990a, 1990b).

CONCLUSION

In sum, the Green Point vicinity has provided the wherewithal to make several substantive and methodological contributions. The data presented make a clear case, we believe, for the longevity of local wetland evolution, as well as the relationship between tended squash stands and the use of floodplains from the Late Archaic through at least the Middle Woodland periods. The earlier, Late Archaic, end of this continuum is apparently consistent

with a floodplain hypothesis for the regional inception of squash horticulture in northern locations. Regular and directed human intervention probably played an important role in this process. Moreover, reports of non-carbonized squash seed recovered from near Late Woodland sites along the Saginaw River system suggests that the pattern described above may have greater duration than we have so far documented. Methodologically, the notion that off-site areas should be routinely and systematically explored as part of a multi-disciplinary regional research strategy implemented at the multiple scales of site, locale, and cultural landscape is one which we believe requires more concerted exploration in our research into crop histories and their cultural associations. Finally, our work further underscores the need to systematically employ curated repository collections for the direct dating of early crop samples. These results must be regularly cast against other independent lines of evidence including pollen, phytoliths, and isotope signatures in the context of multi-disciplinary collaborations including replicative experimentation to understand the processes associated with the development of regional horticultural practices, and how these changes articulate with existing settlement and economic strategies.

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ENDNOTE

¹: Testimony to the increased recognition of off-site phenomenon as significant to the interpretation of on-site records, particularly as related to early agriculture, was the symposium *Ecological Footprint of Early Agricultural Societies: Integrating On-site and Off-Site Records*, recently held at the 72nd Annual Meeting of the Society for American Archaeology (SAA 2007:61).

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CHAPTER 12

SETTLEMENT AND SUBSISTENCE CHANGE AT THE TURN OF THE FIRST MILLENNIUM: THE VIEW FROM THE HOLMEDALE SITE, BRANTFORD, ONTARIO

by Robert H. Pihl, Stephen G. Monckton, David A. Robertson, and Ronald F. Williamson

On going research into the development of maize agriculture among the pre-Contact populations of the Great Lakes region underscores the complex, but not necessarily direct causal relationship between maize and increasing sedentism. Whereas many researchers formerly believed that the introduction of this cultigen ultimately revolutionized the subsistence-settlement systems of the majority of the Late Woodland (ca. A.D. 900–1650) populations of the Northeast, whether or not these new systems were accompanied by new people and/or a new language, such a simplistic position is no longer tenable.

The agricultural “revolution” in southern Ontario, like many others in the archaeological record, was by no means marked by a sudden transformation, as its full effects were not manifest until the twelfth or thirteenth century, during the Middle Iroquoian period (ca. A.D. 1300–1400), although again this was not necessarily experienced by every community or in every area. The ca. A.D. 500–1000 Princess Point complex of the Grand River valley has been seen as the core area in the transition to agriculture in southern Ontario, although the point—or more likely points—at which the other aspects of Late Woodland Iroquoian life that are so intimately associated with the local agricultural economic system crystallized within the Grand River drainage, remains to be discovered. This is the case too with respect to communities elsewhere in southern Ontario and the Northeast in general.

We still have a very poor understanding of intraregional variation in the histories of maize and northern Iroquoian sedentism, although it seems safe to assume that nowhere was there a simple cause and effect relationship between the adoption of maize and the development of sedentism. This was also true for populations that were neighbors to the northern Iroquoians. The Grand River valley remains one of the most promising areas in the Great Lakes in which to investigate such questions, as seen by the recent progress made by the University of

Toronto research program headed by David Smith and Gary Crawford. The complete excavation of the Holmedale site, dating to ca. A.D. 1000, some 500 to 700 years after the first appearance of maize in the area, offers another opportunity to examine these and related issues.

THE PRINCESS POINT COMPLEX

The Holmedale site is one of numerous mid-to-late first millennium A.D. sites that have been found along the lower reaches of the Grand River between Brantford and Lake Erie. These sites (Figure 12-1), together with others within the region, were collectively defined as comprising the “Princess Point complex,” which was marked, in part, by the introduction of cultigens to the region. Otherwise, however, it was believed that the settlement-subsistence systems of the previous Middle Woodland period (ca. 400 B.C.–A.D. 800) had remained virtually unchanged. Indeed, David Stother’s (1977:122) original characterization of the basic Princess Point subsistence-settlement system proposed that for most of the period, communities followed an annual subsistence cycle involving interior fall and winter microband hunting camps, which were situated to exploit nuts and animals attracted to mast-producing forest, and larger spring and summer macroband settlements, which were located on major rivers and lakeshores in order to take advantage of rich aquatic resources. Warm season occupations likely also entailed limited agricultural pursuits, although for the most part subsistence-settlement patterns were consistent with the strategies of populations of the preceding Middle Woodland period. Stothers further suggested (1977:162–165) that the end of the Princess Point period (ca. A.D. 850) witnessed an intensification of food production and sedentism that heralded the onset of Early Iroquoian period (ca. A.D. 900–1200), resulting in another settlement

pattern shift toward more sedentary communities situated in well-drained sandy uplands. Subsequently other researchers questioned various aspects of this model, suggesting, for example, that the archaeological record was not sufficiently detailed to allow the macroband/microband hypothesis to be rigorously tested (e.g., Fox 1990:179).

It has always proven difficult to incorporate the Princess Point complex within the existing culture history of southern Ontario. In his original description, Stothers (1977) argued that this cultural manifestation represented the original incursion of Iroquoians into southern Ontario sometime after ca. A.D. 400. This hypothesis lost support when Fox (1982, 1984, 1990) reassigned Stothers' "Point Pelee" focus of Princess Point to the ca. A.D. 600–900 Riviere au Vase phase of the Western Basin Tradition, which encompasses a series of Late Woodland manifestations on both sides of the Canada-United States border within the drainages of western Lake Erie, Lake St. Clair, and lower Lake Huron (Fox 1990; Murphy and Ferris 1990; Stothers and Pratt 1981). Fox (1982, 1984) also eliminated Stothers' "Ausable" focus on the southeast shore of Lake Huron as being too ill-defined. The remaining Ontario focus on the Grand River was generally thought to represent cultural continuity and a genetic relationship between the preceding Middle Woodland populations and the subsequent Late Woodland (Early Iroquoian) communities of the region (e.g., Fox 1990; Molto 1983; Spence et al. 1990; Warrick 1990). An even more vaguely understood Sandbanks construct is characterized as a small number of widely dispersed sites at the eastern end of Lake Ontario and the north shore of the St. Lawrence River. These apparently date to the ca. A.D. 800–1000 period and have produced "Princess Point-like" ceramics (Curtis 2002; Daechsel and Wright 1988).

The Princess Point "complex" has also sat uncomfortably in the taxonomic framework that has generally underlain lower Great Lakes archaeology. Some authors (e.g., Ferris 1999; Ferris and Spence 1995; Fox 1990; Spence and Pihl 1984; Williamson and Robertson 1994) in recognition that these other mid-to-late-first millennium A.D. sites represent cultural developments that are intermediate between the patterns of the preceding Middle Woodland and subsequent earlier periods within the Late Woodland Iroquoian and Western Basin Traditions have a new category termed the "Middle to Late Woodland Transition" or "Transitional Woodland" in an attempt to overcome the constraints of the existing taxonomy. This assignment has been shown to be taxonomically problematic as well (Smith 1997a; Smith and Crawford 1997).

In the past decade or so, the Middle to Late Woodland transition has reemerged as an important topic of debate and research for a number of reasons. In the early- to mid-1990s, for instance, Dean Snow renewed the idea of

Iroquoian incursion into New York and Ontario during the Middle to Late Woodland transition (Snow 1992, 1994, 1995a, 1995b). In Snow's model, the founding population of the Iroquoian-speakers of southern Ontario and west-central New York originated with the central Pennsylvanian proto-Iroquoian Clemson's Island complex. Snow characterized these Pennsylvanian groups as already possessing many traits associated with the Iroquoian cultural repertoire (in particular, maize agriculture and technologically more sophisticated ceramic vessel manufacturing traditions) prior to their expansion northward. He further asserted that these traits were in large degree mutually dependent; other distinctive Iroquoian traits, those of matrilineal descent and matrilineal residence patterns within palisades villages composed of longhouses, were seen as an adaptive response on the part of these small groups of immigrants to hostilities that arose between them and the native Algonquian-speaking groups of southern Ontario and New York. Originally, Snow (1992, 1994, 1995a, 1995b) proposed that this migration occurred ca. A.D. 900, based on the "sudden" appearance of maize on Ontario and New York sites and apparent ceramic and other material culture and settlement pattern discontinuities between Middle Woodland and Princess Point traditions in Ontario and between Middle Woodland and Owasco in New York.

Snow's chronology was upset almost immediately by some of the results of a research program into the origins of agriculture in the lower Great Lakes that was initiated in 1993 by David Smith and Gary Crawford of the University of Toronto. This work initially involved site survey and excavation at Princess Point sites along the Grand River in the Cayuga area and at Cootes Paradise on Burlington Bay at the west end of Lake Ontario (Figure 12-1). Although perhaps presaged by Lawrence Jackson with his earlier research in the Rice Lake area (Jackson 1983), Crawford and Smith's most outstanding finding was that maize was present at several of the Cayuga sites as early as ca. A.D. 550 (Crawford et al. 1997; Crawford and Smith 1996; Smith 1997a; Smith and Crawford 1995, 1997). They further suggested that the overall span of Princess Point should be expanded to ca. A.D. 500–1100 and that Princess Point co-existed for several centuries with Middle Woodland cultural expressions to the west and east and with later Early Iroquoian manifestations from around A.D. 900 to A.D. 1000 (Smith 1997a; Smith and Crawford 1997). They also speculated that in the lower Grand River valley, "Princess Point society was dependent on food production as a subsistence regime" by ca. A.D. 1000, accompanied by "more centred communities" (Smith and Crawford 1997:27).

In response to Crawford and Smith (1996), Snow (1996) revised the timing of the proto-Iroquoian migration to around A.D. 600, but failed to account for the fact that

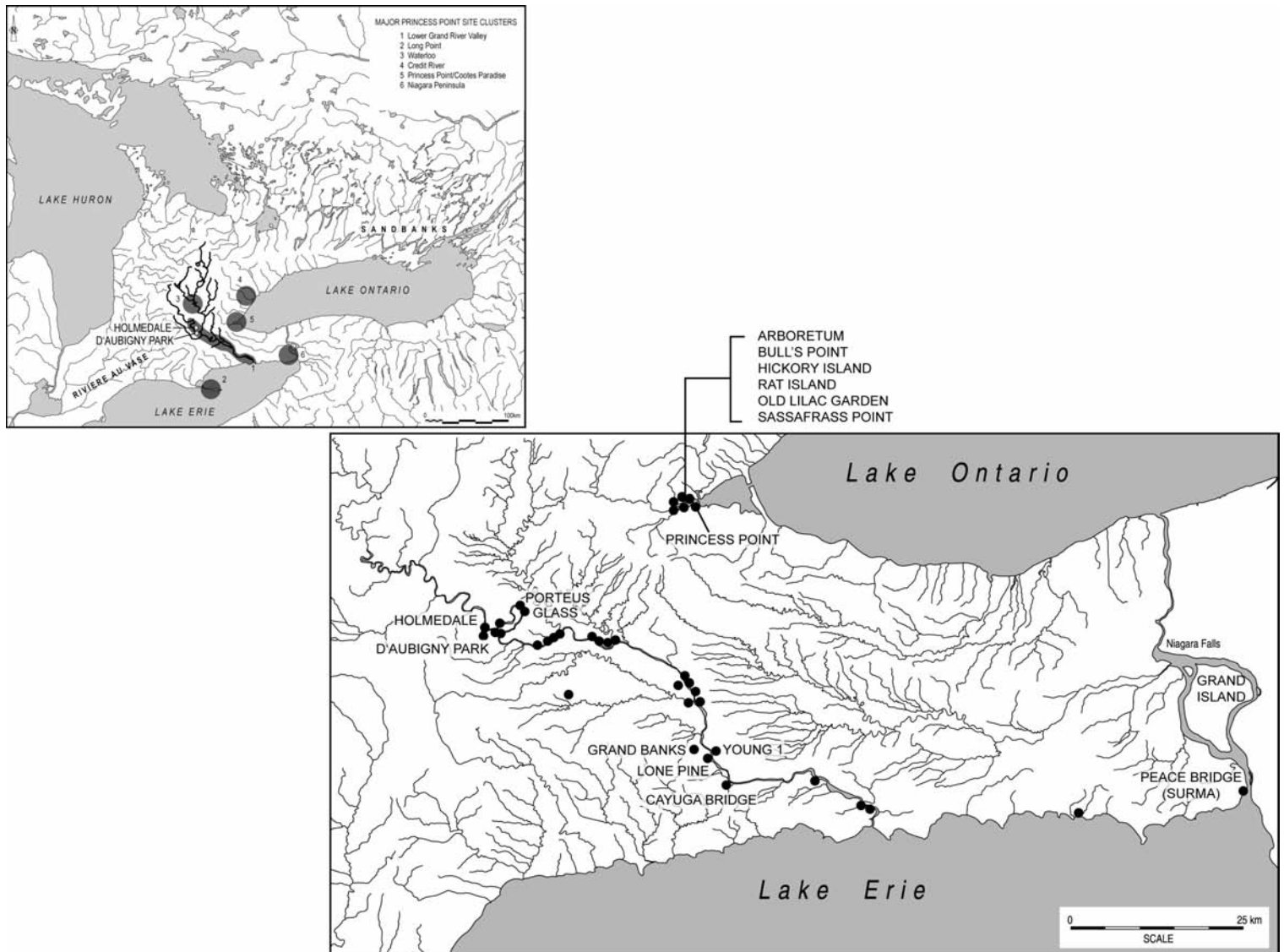


Figure 12-1. The location of the Holmedale site and other Princess Point site clusters in southern Ontario.

there is currently no evidence to suggest that maize was present on Clemson Island sites any earlier than on sites in Ontario (Hart 2001:170), nor for the fact that the status of Clemson Island vis-à-vis other contemporary regional groups requires further resolution (Hart and Brumbach 2003).

Other elements of Snow's arguments have been challenged as well. Many of the material cultural "discontinuities" cited as evidence for a population incursion in southern Ontario, for example, are oversimplifications of the archaeological record (Crawford and Smith 1996:788). The classic Middle Woodland ceramic wares of the Northeast (including Vinette 2 or Point Peninsula ware), for instance, feature vessels decorated with distinctive motifs executed by pseudo-scallop shell and dentate

stamping, drag- (or push-pull) stamping and rocker-stamping often combined with incising. These vessels possess a distinctive conoidal shape. These were superseded by a more globular shaped, cord-wrapped stick decorated ware manufactured using somewhat different techniques, ca. A.D. 500–800. This change is viewed as partial evidence for this hypothesized population replacement. While changes in ceramic technology and styles certainly occurred during this period, they are not as revolutionary as the migration proponents have suggested. For instance, it is well known that classic Middle Woodland pottery was manufactured by coiling and that later pottery was constructed by modelling (or building by accretion or lamination). Snow (1994, 1995a, 1995b, 1996) and others (e.g., Bursey 1995) argue that modelling

represents an introduced technology. While coil breaks are uncommon in some ceramic samples from this period, Fox (1995:145) has argued that they occur in other samples with sufficient frequency to suggest a more gradual technological evolution. It might also be argued that the newer techniques were employed to make the pottery stronger and more resistant to coil breaks therefore representing a technological advance rather than replacement. Also linked to the new manufacturing technique is a perceived significant decrease in average wall thickness. While post-Middle Woodland vessels are undeniably thinner, empirical studies to document average vessel wall thickness over time (e.g., Braun 1983) have yet to be completed for northeastern ceramic samples. It remains a matter of speculation as to whether or not the results of such an analysis would show a one-time dramatic decrease in coil manufacture consistent with an introduced ware, or a gradual decrease consistent with increasingly refined manufacturing techniques. In the interim, a more cautious approach should be taken, given the existence of "post-migration period" vessel assemblages that exhibit attributes typical of the "pre-migration period." A complete vessel recovered from the Peace Bridge site in Fort Erie is a case in point. The reconstructed vessel, carbon encrustations on which have been AMS dated to 1330 ± 60 B.P. (cal. 2σ A.D. 625–860, I-5243), has a classic Middle Woodland vessel shape including a conoidal body and conical base. It is undecorated, with a heavily cord marked exterior and smoothed interior, and is thus reminiscent of wares assigned to the ca. A.D. 900–1000 Hunters Home phase in New York (Ritchie 1965:253; White 1964:13). Although the context is post-Middle Woodland, the vessel's morphology is not; the more traditional vessel style was clearly persistent (Pihl 1997:404; Robertson et al. 1997:502–503). This is not an isolated example of continuity and overlap in the regional ceramic traditions of the Middle to Late Woodland transitional period (e.g., Smith 1997a; Gates St-Pierre 2001; Hart and Brumbach 2005). Rather than being indicative of population replacement, such patterns are more consistent with the idea that if Iroquoians truly were recent arrivals to southern Ontario, then it is more likely that they influenced the technologies, economies, and language of the local populations rather than replaced them.

A second case in point is the Scott-O'Brien site, a 0.4 hectare multi-component site situated on the Credit River west of Toronto. Ceramics recovered from over 100 pit features include substantial quantities of Early Woodland Vinette 1 pottery (ca. 800–400 B.C.), Saugeen and Point Peninsula Middle Woodland wares (ca. 400 B.C.–A.D. 500), as well as Princess Point ceramics (Williamson and Pihl 2002); in total an assemblage that suggests an unbroken tradition of site use. Similar continuities in site occupation have also been documented in the Rice Lake area,

where many sites manifest an unbroken ceramic tradition spanning the Middle Woodland, the Middle to Late Woodland transition (Sandbanks), and Early Iroquoian periods (Curtis 2002).

Of course continuity in some areas and discontinuity in others is a possibility, and it may simply be too early to rule out migration as *one* of the processes involved in the Middle to Late Woodland transition (Smith and Crawford 1997: 28) and the spread of agricultural systems across large areas (Bellwood 2005). Nevertheless, the new migrationists have yet to provide a coherent argument outlining how a small intrusive population managed to displace or absorb the thousands of—presumably Algonquian-speaking—people distributed in geographically disparate regional groupings across southern Ontario and western and central New York, creating, in the process, an "island" of Iroquoian speakers in the middle of a "sea" of Algonquian speakers. Accordingly, Snow's hypothesis has been met largely with scepticism on the part of Great Lakes archaeologists (e.g., Clermont 1992; Crawford and Smith 1996; Engelbrecht 1992, 1999; Ferris 1999; Ferris and Spence 1995; Fox 1995; Hart 2001; Smith and Crawford 1995, 1997; Warrick, 1992, 2000; Williamson 1992; Wright 1992).

Historical linguists have also attempted to address this question through examining the origin and dispersal of Algonquian and Iroquoian languages, using glottochronology. Fiedel (1999), for instance, has suggested that a Proto-Algonquian language family emerged in the Great Lakes region during the Late Archaic period, ca. 1200 B.C. Cognate comparisons of Algonquian languages suggest a divergence of the Proto-Algonquian language family occurred sometime during the Middle or Early Late Woodland Period (ca. 500 B.C.–A.D. 900). Fiedel has suggested that the most likely archaeological complex responsible for the initial Proto-Algonquian expansion would be the Middle Woodland Point Peninsula Complex of southern Ontario. Point Peninsula spread north, giving rise to the Laurel Complex of northwestern Ontario, and east into New York, New England, and the Maritimes region ca. 200 B.C.–A.D. 200 (Fiedel 1999:198–199). Fiedel (1999, citing Fitting 1965; Ritchie 1965:207) notes that ceramic form and decoration during this time is virtually consistent through the greater Northeast area. This homogeneity was maintained through the early Late Woodland period (ca. A.D. 700–900) based on the trade in exotic material culture between Michigan, Ohio, Ontario, New York, Delaware, and Vermont (Fiedel 1999:199–201). Yet the validity of the Point Peninsula "Complex" as a real cultural entity is questionable and it may be preferable to regard Middle Woodland populations as politically autonomous with a mobile hunter-gatherer economy and flexible group boundaries (Spence et al. 1990:143, 148, 157; Williamson

and Pihl 2002; Wilson 1991).

Regarding the Iroquoian language family, Fiedel (1999:201) has stated that Iroquoian languages are “totally unlike” Algonquian languages in vocabulary, phonology, and grammar. This leads him to suggest that the two language families may be relatively recent neighbors in the upper northeast. The Iroquoian presence in this region is attributed to a recent migration, ca. A.D. 500–1000, based on glottochronological evidence provided by Lounsbury (1961, 1978). This interpretation is largely consistent with the Iroquoian migration theory proposed by Snow (1994, 1995a, 1995b, 1996; cf. Whyte 2007).

Linguistic reconstructions of this type also look to archaeological evidence for support, but in doing so assume, perforce, that there are strong links between specific forms of material culture, chiefly ceramics, and language. However, determining ethnicity in the archaeological record is a daunting endeavor, particularly due to the problematic relationship between differences in material culture and the extent to which these differences reflect disparate group identity or ethnicity. The archaeological record of this region is sparsely endowed with objects that unambiguously reflect ethnic affiliation, or serve as “ethnic boundary markers.” In traditional cultural-historical schemes, the main underlying assumptions regarding style have been that ceramic attributes reflect ethnic identity, and that, more importantly, sociopolitical dominance is normally evinced by increasing frequencies of traits belonging to the predominant group. This is a notion for which there is substantial contradictory cross-cultural evidence. It has been noted elsewhere (Hodder 1978:4–9) that vessel shapes and design motifs often remain the same among a conquered population, despite significant acculturation. Furthermore, invaders might intrude upon settled populations and their arrival may not be identifiable in ceramic patterns for a number of centuries. The traditional approach assumes that potters too easily accept the legitimization of control and are quick to embrace a new and dominant ideology (Hodder 1986:26). For the Great Lakes region in particular, it has become increasingly clear that Iroquoians and Algonquians alike participated in a tradition of ceramic vessel manufacture that enjoyed comparatively widespread currency throughout much of the Northeast (e.g., Brumbach 1975, 1995; Moreau et al. 1991:58; von Gernet 1992:122–123, 1993:77). Determining the relationships between artifacts and ethnic groups is further complicated by the overlapping territories and high degree of social mobility often ascribed to the various groups in this region, the apparent openness of social groups to new members through adoption, and the drastic population movements and realignments which appear in European accounts of seventeenth- and eighteenth-century life in throughout the Great Lakes region (cf. Engelbrecht 1999).

Despite our limited knowledge of the period, the events of the Middle to Late Woodland transition are of great significance to the subsequent culture history of the region. The adoption of maize must ultimately have had an important role in initiating the transition to food production and reducing the traditional reliance on naturally occurring resources; however it would seem that this process was much more gradual than previously thought. Likewise, it is probable that it was highly variable from one area to the next. In some areas this shift may have been accomplished simply through local populations adopting agricultural practices and associated customs or ritual. In other areas, it is equally possible that the arrival of new peoples were initially responsible for the changes apparent in the archaeological record. The Iroquoian languages may have spread into the lower Great Lakes area through either means—the process being facilitated by the fact that social and ethnic boundaries were flexible and permeable to the individuals and groups who were active agents in their creation in the first place.

The incipient agriculture of these communities may have led to decreased mobility as at least some members of the community likely remained near their garden plots for longer periods of time to tend their crops. While it may be possible to overestimate the role of maize in this process, it seems clear that sites were more intensively occupied and subject to a greater degree of internal spatial organization and, increasingly, were located on terraces overlooking the floodplains of large rivers. In southern Ontario this pattern is most clearly seen in the Grand River valley at the later Princess Point sites of Porteus (Noble and Kenyon 1972; Stothers 1977) and Holmedale (Pihl 1999a), and to a lesser degree at Grand Banks, Lone Pine, Forster, and other sites tested by the University of Toronto research program (Bursey 2003; Crawford and Smith 2002). Holmedale, however, is the only site that has been excavated on a large scale to reveal the full community plan, since the Porteus investigations of the 1970s.

THE HOLMEDALE SITE

Located on the floodplain of the Grand River in the City of Brantford, the Holmedale site is situated along a low terrace that traverses an oxbow formed by the river, the current course of which flows approximately 250 meters to the south (MacDonald and MacDonald 1999). Previous development activities within the area have considerably altered the setting of the site. Although Holmedale was covered by woodlot and scrub and brush at the time of its initial discovery, it was formerly cultivated. Early twentieth-century topographic mapping also indicates that a sizeable back-water channel or creek and associated marsh formerly lay to the immediate east of the site

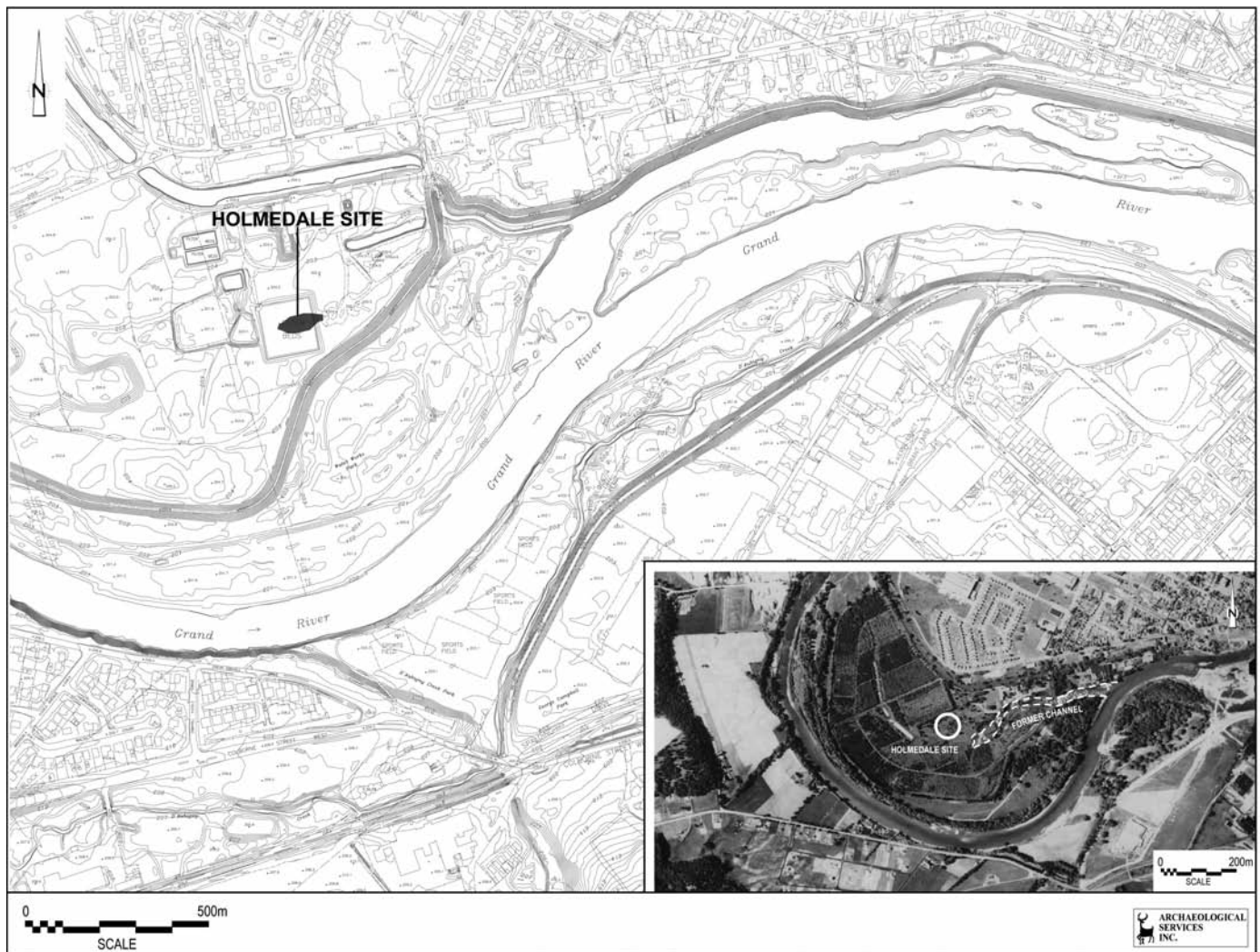


Figure 12-2. The setting of the Holmedale site on the Grand River.

(Figure 12-2).

The Holmedale site was discovered in 1996, during the course of a test pit survey undertaken in advance of proposed upgrades to an existing water treatment plant (Pihl and Robertson 1999). Artifacts were recovered from a total of 50 test pits distributed over approximately 0.5 hectare. The south side of the site rested on a ridge overlooking an elongated depression or swale. Following its discovery, the site was fully excavated through the hand excavation of one meter units and mechanical stripping of plough-disturbed soils (Figure 12-3). In total, an area of approximately 2,920 m² was investigated. The excavations uncovered 63 cultural features, in the form of pits and hearths, together with over 700 post molds (Robertson 1999). The artifact assemblage consisted of approximately 16,000 items.

The main focus of settlement activity at the site appears to have been concentrated in an area delineated by a

major row of palisading and a series of fences (Figure 12-3). The variable orientations of the perimeter fence sections, together with the fact that they frequently bisect areas of concentrated feature activity, suggests that the compound may have been expanded or contracted on one or more occasion to meet the changing needs of the inhabitants of the site during their successive occupations. Unfortunately, the form of the area defined by the fences at any one time cannot be discerned with any degree of confidence, due both to the discontinuous patterns of the post lines and to the possibility that the construction of some of the house structures may have incorporated sections of fencing as house walls or vice versa. Whether or not such use of common architectural elements occurred as one or the other became redundant cannot be determined.

The greatest concentration of activity appears to have been confined to an oval-shaped area measuring approx-

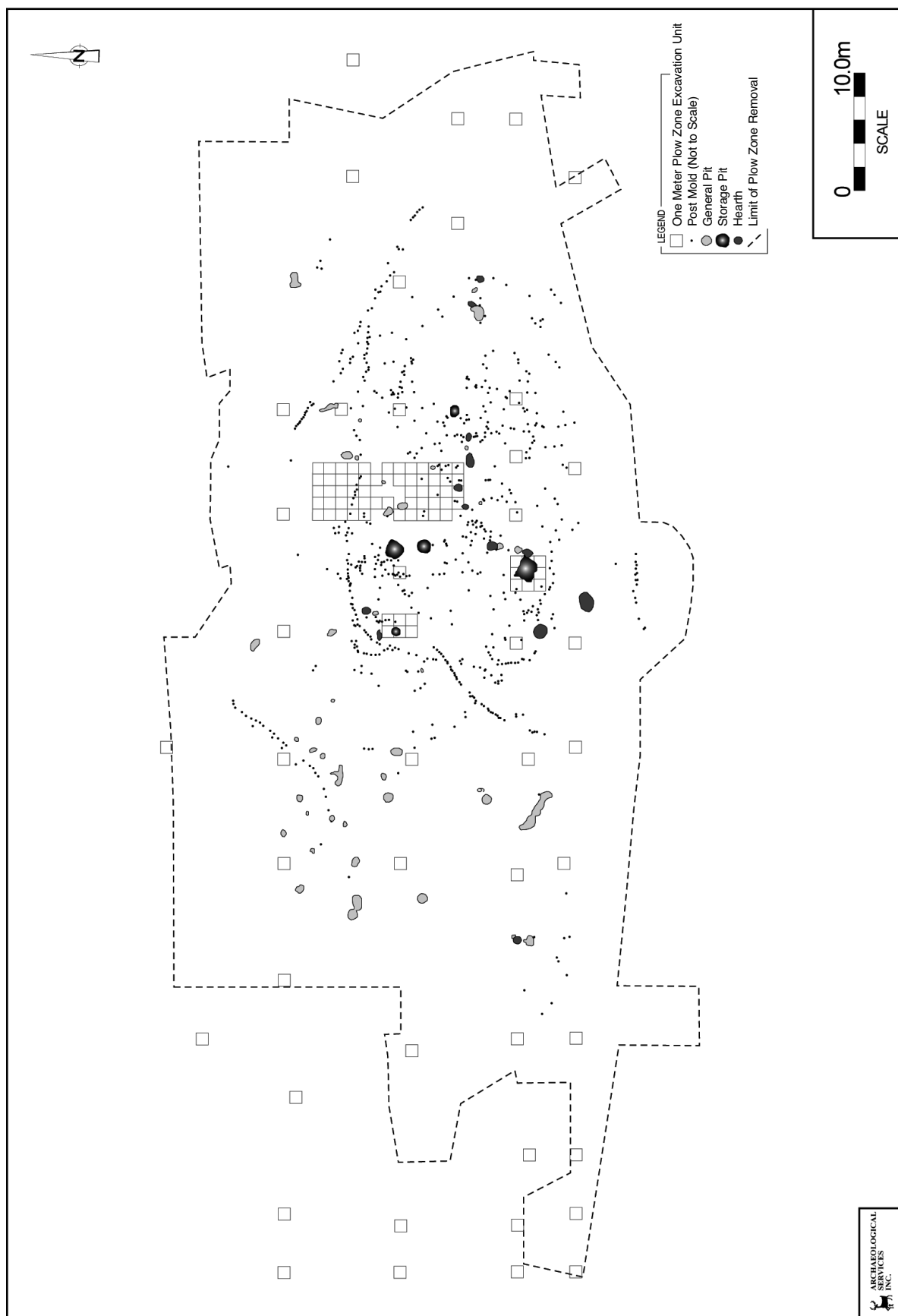


Figure 12-3. The excavation of the Holmedale site.

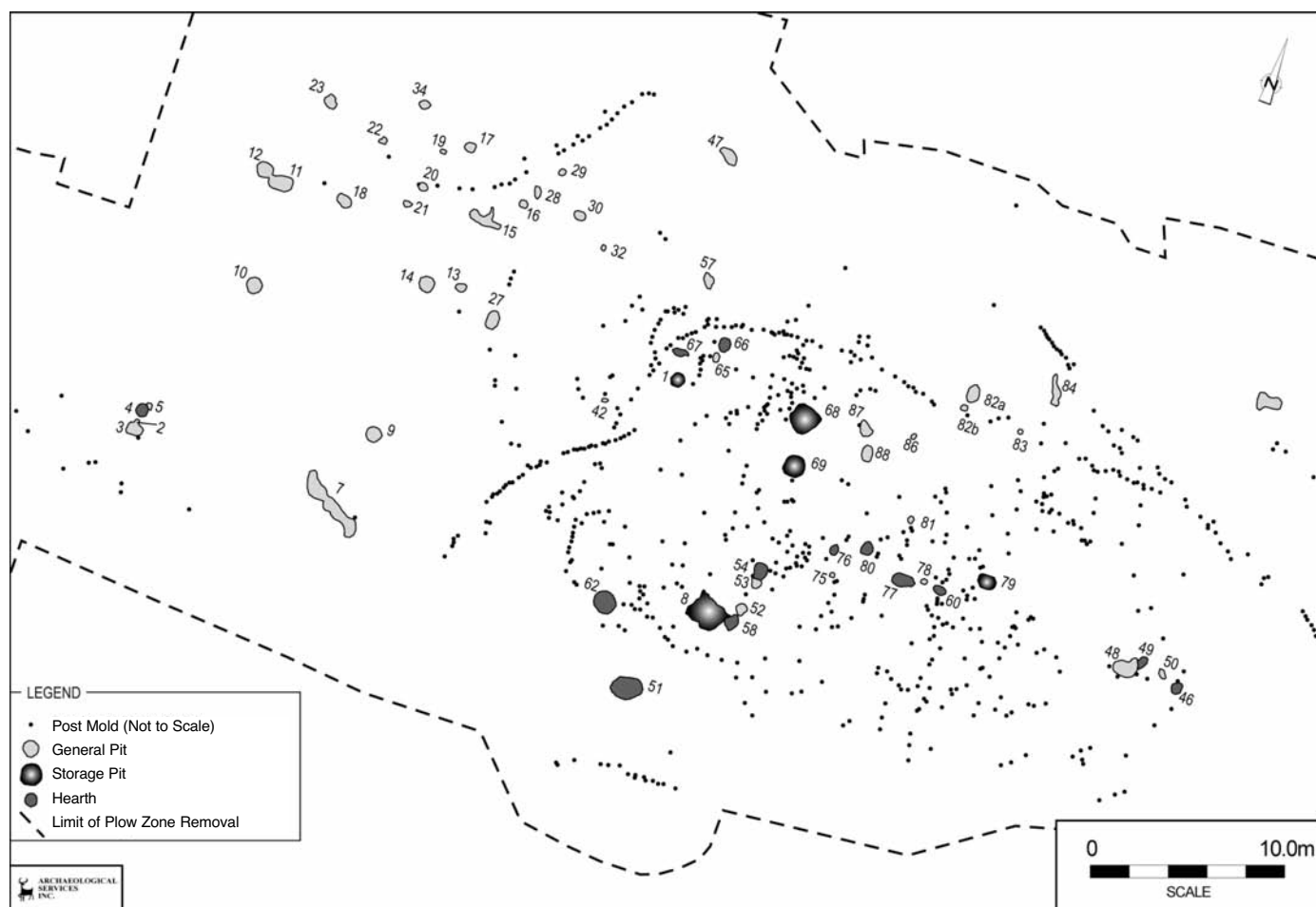


Figure 12-4. The primary occupation area within the settlement area.

imately 650 m². Within this compound (Figure 12-4), at least nine potential clusters of hearths and pits are readily apparent. Each feature concentration is associated with scatters of post molds of varying densities and configurations; however, few well-defined house structures are immediately evident. This pattern is reminiscent of those found on many slightly later Early Iroquoian sites. In the past, such settlement patterns, formed by overlapping lines of posts, amorphous clusters, or simply broad areas of isolated posts that exhibit little patterning of any sort have been interpreted as reflecting an absence of community planning and concomitant lack of formal village government, low population densities, and short-term but frequently repeated occupations during the cold-weather months (e.g., Noble 1968; Trigger 1981; Williamson 1990). More recently, however, highly detailed analysis of the Early Iroquoian Calvert site (Timmins 1997) has clearly demonstrated that the apparent randomness and lack of order on such sites is largely a consequence of the use of these sites over the course of many years, during which

period each occupation was much more formally structured than previously assumed.

Notwithstanding the difficulties presented by settlement pattern data, the structures that are hypothesized at Holmedale are largely consistent in terms of size and form with many of those documented at other roughly contemporary or slightly later settlements such as Auda (Kapches 1987:Figure 2), Boys (Reid 1975:Figures 5 and 12), Van Beisen (Noble 1975:Figure 2); and the nearby Porteus site (Noble and Kenyon 1972:Figure 3; Stothers 1977:125). They also resemble the small circular to elliptical houses encountered on many somewhat later sites, such as Reid (Wright 1978:Figure 2), Elliot (Fox 1986b:Figure 4), Roeland, Yaworski, and Bermortel (Williamson 1985:Figures 14, 24 and 25), and Calvert (Timmins 1997:Figure 5.1), in conjunction with structures that are more recognizable as “longhouses.”

In the extreme northwest corner of the compound and immediately adjacent to the palisade, a pair of hearths (Features 66 and 67), separated from one another by a dis-

tance of approximately two meters, was found in association with a small, shallow pit (Feature 65), which was devoid of artifactual remains, and a large storage pit (Feature 1). Feature 1 measured 71 cm in length, 64 cm in width, and 80 cm in depth, and was composed of four major fill layers. Considerable quantities of ceramic sherds, derived from at least four separate vessels, almost 200 pieces of lithic debitage, and over 900 pieces of faunal debris were recovered from the fill of the pit.

The presence of two short alignments of posts, one of which traversed the main palisade row to the north and west of Features 1 and 67, while the other lay intermediate between them to the east, indicates the presence of a structure measuring approximately 3.5 m in length and 2.5 m in width that was oriented roughly north-south. Only one hearth (Feature 67) and the large storage pit (Feature 1) would have constituted interior features while the second hearth (Feature 66) and the small pit (Feature 65) were exterior to the house. The structure was not contemporary with the palisade.

To the immediate east of the Feature 1/65–67 complex, an approximately 6.5 m long line of irregularly spaced posts may represent the west side wall of another structure. Three pairs of posts extending eastward from the southern terminus of this alignment, and an amorphous cluster of seven posts at its northern end may be indicative of end walls. Two large storage pits (Features 68 and 69) may constitute centrally aligned interior features associated with this potential house, suggesting that the structure may have measured approximately 2.75 to 3.0 m in width. The smaller of the storage pits (Feature 69) had a diameter of 105 cm in plan view and was 50 cm deep. Its fill was comprised of two major layers, which contained portions of at least 17 ceramic vessels, nine formal flaked lithic tools, over 500 pieces of debitage and over 460 pieces of faunal debris. Feature 68, on the other hand, measured 165 x 150 x 65 cm, and three major strata were apparent within its fill. Portions of at least six ceramic vessels, 13 formal flaked lithic tools, and around 250 pieces of chert debitage, but only 37 faunal were recovered from this pit.

To the south of the Feature 68 and 69 pairing, two hearths (Features 54 and 58), were found to be separated from one another by a distance of approximately 2.5 m. Feature 54 predated a general refuse pit (Feature 53), while Feature 58 was flanked by a pit (Feature 52), which predated a large post, and the largest of the storage pits documented at the site (Feature 8). Feature 8, which measured 179 cm in length, 142 cm in width and 92 cm in depth, contained five major depositional strata, which yielded portions of at least 22 ceramic vessels, 24 formal lithic tools, approximately 1,800 pieces of chert debitage, and 2,200 faunal specimens.

The definition of potential structural elements associated with this feature cluster is problematic. A roughly 7.0

m long line of as many as 23 single-spaced to irregular clustered posts, located approximately two meters to the southwest of Feature 8, may indicate the presence of one wall. Similarly, a dense cluster of posts to the immediate northeast of Feature 54 may indicate the presence of a wall in this location. Taken together, these potential house walls may indicate the presence of a structure of roughly 8.3 m in length and perhaps 6.4 m in width. The large post that was dug through Feature 52 may have served as a roof support.

A short distance to the west of Feature 8, a single hearth (Feature 62) occurred in apparent association with three comparatively well-defined lines of single-spaced and paired posts that extend to the northwest and which may represent the sides and north end wall of an open-ended structure measuring approximately four to five meters in length and three meters in width. The west side wall of the structure may, at some point, also have constituted a portion of the main palisade row.

Two potential—and possibly overlapping—structures also occurred to the north and east of the postulated house containing Features 8, 52–54, and 58. Within this area four hearths (Features 60, 76, 77, and 80) formed two separate, but parallel-aligned pairs. In each case, the distance between the two hearths (Features 76 and 80; 77 and 60, respectively) measured approximately 2.0 m. The intervening space between the Feature 60/77 pair was occupied by a small pit (Feature 78). Two other pits (Features 75 and 79) may also be associated with this occupation area. Feature 75 was a small, shallow, generalized pit, while Feature 79 was a storage pit in-filled by two major strata that contained very few artifacts of any sort.

Approximately seven meters to the east of Feature 79, in the southeast portion of the primary settlement area a pair of hearths (Features 46 and 49) separated from one another by a distance of approximately 2.0 m, together with two pits (Features 48 and 50) and 18 scattered posts form a discrete activity area. Although the distance between the hearths and the pairing of hearths and pits is similar to that noted for the other postulated houses, no alignments of posts that might be suggestive of walls were evident.

Approximately nine meters to the northwest of the Feature 46/48/49/50 concentration and adjacent to the easternmost palisade line, another structure may be indicated by the presence of a U-shaped line of 26 paired or staggered posts, which may represent the rounded west end wall and portions of the sides of a house measuring approximately 6.5 m in length and 3.25 m in width. It is also possible that a rounded eastern end wall may be indicated by three widely spaced posts. Other than two post moulds in the approximate centre of this potential house, there is a dearth of further evidence for “interior” activity.

A number of other features that do not appear to have

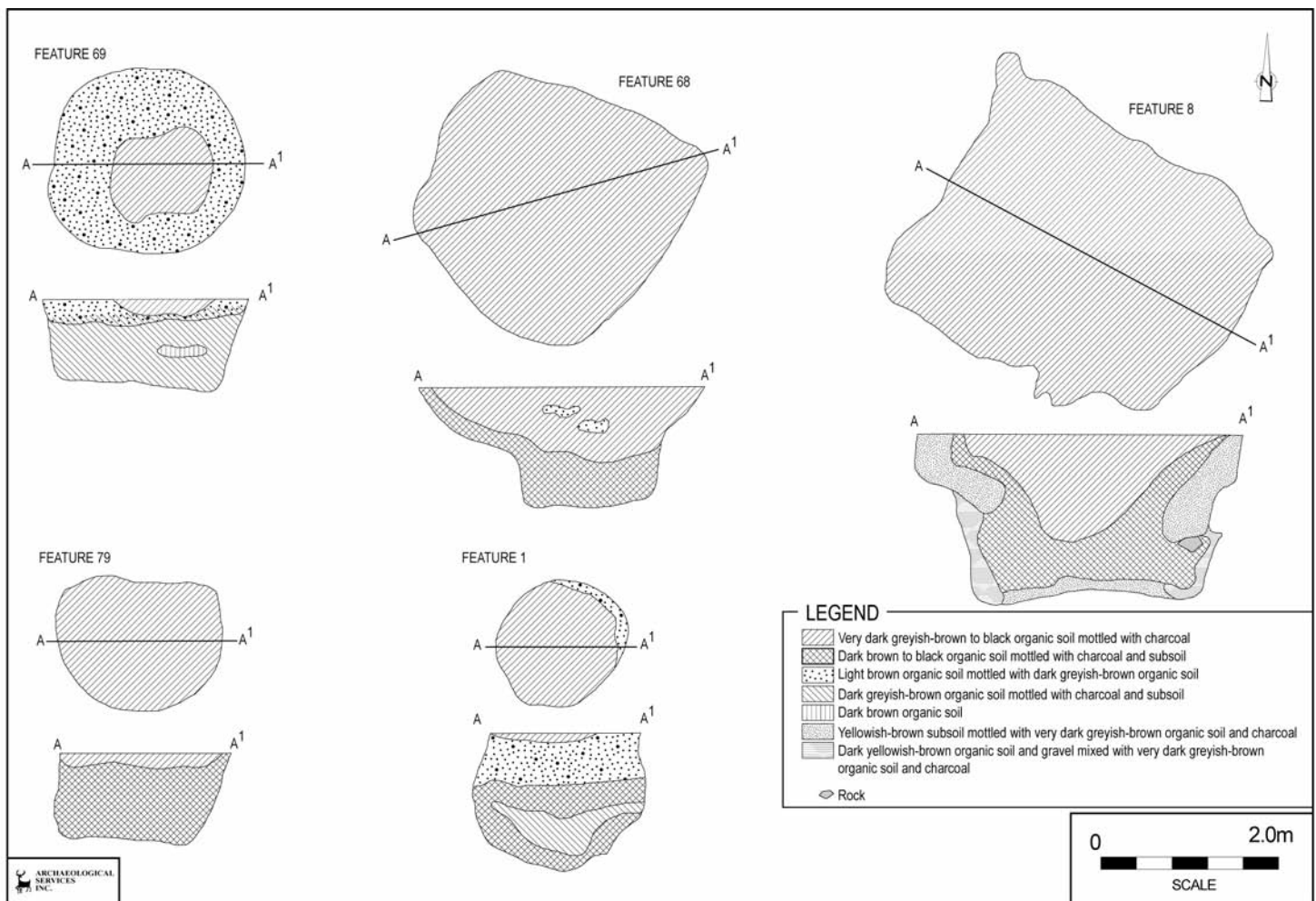


Figure 12-5. Plans and profiles of the Holmedale site storage pits.

been contained within any structures were scattered throughout the main settlement area and a significant concentration of exterior activity appears to have occurred to the northwest of the primary settlement compound. Much of this activity seems to have been focused on an approximately 10-meter long fence row of single, evenly spaced posts.

Four of the postulated house structures were associated with large deep features that likely served as large storage pits that were subsequently used for refuse disposal. Such features are frequently found on transitional Middle to Late Woodland or early Late Woodland sites (e.g., Bursey 2003; Fox 1976:182; Lennox: 1982:10; Murphy and Ferris 1990:235–236; Timmins 1997:156–160) and, in general, exhibit deep basin to cylindrical flat-bottomed, or bell-shaped profiles, as well as complex layering and lensing, indicative of gradual or periodic backfilling, weathering, and erosion of the exposed walls of the pit, and possibly re-use.

The Holmedale storage pits (Figure 12-5) compare favorably with the sample of 68 features from the Early Iroquoian Calvert site that has been analyzed in considerable detail by Peter Timmins (1997), who noted that the average dimensions of the Calvert examples were 127 cm in length, 112 cm in width, and 70 cm in depth, providing for an average capacity of approximately 1.0 m³. The Calvert features generally possessed fill comprised of three to four strata (Timmins 1997:Table 7.24). The five Holmedale examples, on the other hand, had mean dimensions of 124 x 106 x 65 cm, and a mean volume slightly in excess of 1.0 m³. The fills of the pits were comprised of two to five major depositional strata.

It has generally been assumed that the primary function of pits of this type was cold season storage of maize or other foodstuffs, and that in order to be effective, it would have been necessary to provide the features with a bark liner (e.g., Bursey 2003:212; Fox 1976:182; Lennox 1982:10; Murphy and Ferris 1990:236; Timmins 1997:156).

While Gabriel Sagard (Wrong 1939:95) has frequently been cited as ethnohistoric confirmation of the use of bark linings in underground storage pits (e.g., Heidenreich 1971:119; Timmins 1997:149), and he certainly described “large vats or casks of tree-bark,” his discussion did not make explicit reference to bark-lined pits.

The probability that such a liner would deteriorate within a comparatively short period of time has led to the further assumption that the use-life of these storage pits was comparatively brief and that they would subsequently be used for refuse disposal (Timmins 1997:156). Although Timmins (1997:150–156) has devoted considerable effort to replicative studies concerning the post-abandonment processes responsible for the formation of the features recognized as storage pits, rather less consideration has been given to testing traditional assumptions concerning aspects of storage technology, such as the need for a bark lining, or the potential longevity of such features. Experimental data directly relevant to such questions, however, are available as a result of long-term research concerning grain storage in underground “silos” during the British Iron Age (Reynolds 1981:22–24). Such work has established, for instance, that the presence of a pit lining is not a critical factor in the preservation of grain. Rather, the key agent in the preservation process is the natural respiration cycle of the grain itself, which consumes oxygen and produces carbon dioxide as a waste by-product. Thus, grain placed in a sealed container consumes all of the available oxygen and will enter a state of unstable dormancy in the resulting carbon dioxide-charged atmosphere (Reynolds 1981:22). Until an anaerobic atmosphere is achieved, the germination of the grain at the interface of the pit walls and surface seal of the pit produces a dense layer of sprouts and rootlets that acts as a barrier to moisture penetration from the surrounding soil, while at the same time the bulk of the stored material is protected from further deterioration (Reynolds 1981:23). Upon removal of the stored grain, the pit is left with a matt of sprouted grain adhering to the walls, which may then be peeled away and discarded, either in a midden or by burning it in situ if there is no further intention of using the feature for storage. If the former option is pursued, however, there appear to be no real limits placed upon the continued viability of the storage pit (Reynolds 1981:23–24). The ultimate abandonment of these features may, therefore, be equally due to other factors that are more closely related to changes in household or community size and composition on a seasonal or more long-term basis; changes that on the basis of the other settlement pattern evidence may have been considerable.

DATING THE SITE

Two samples of carbonized plant remains recovered from the site were submitted for radiocarbon dating. Both dates were subsequently calibrated using CALIB 5.0 (Stuiver and Reimer 1993) with the calibration dataset IntCal04 (Reimer et al. 2004).

A single carbonized maize kernel (86 mg) from Feature 1 was submitted to the University of Toronto’s IsoTrace Radiocarbon Laboratory, Accelerator Mass Spectrometry Facility, for an AMS date, yielding a result of 1010 ± 70 B.P. (TO-6079; cal. 2σ A.D. 890–1210). The second date was run on a 3.96 g sample of carbonized walnut fragments collected from Features 1 and 7. This material was sent to the University of Waterloo’s Environmental Isotope Laboratory for a conventional date, and yielded a result of 1080 ± 80 B.P. (WAT-3005 cal. 2σ A.D. 770–1160). Both dates are chronologically consistent with artifactual remains from the site, notably the ceramics, and are therefore considered acceptable. Using the modal dates, a site occupation spanning ca. A.D. 980–1020 is thus minimally indicated.

The Holmedale occupation therefore falls at the later end of the Princess Point time range suggested by Crawford and Smith (Figure 12-6), roughly contemporary with radiocarbon dated sites such as Bull’s Point (Smith 1997a, 1997b), Grand Banks (Smith and Crawford 1997), Lone Pine (Smith and Crawford 1997), Selkirk 5 (Fox 1978; Smith 1997a), Varden (MacDonald 1986; Smith 1997a), Porteus (Smith 1997b; Stothers 1977), Moyer Flats (Fox 1986a; Smith 1997a), and Stratford Flats (Fox 1984; Smith 1997a).

The assemblage of 65 identified ceramic vessels recovered from the site (Figure 12-7) supports this general chronological placement (Pihl 1997, 1999b). The vessels are characterized by an absence of coil breaks, and the large number of exfoliated sherds suggests that the vessels were manufactured by modeling or accretion and not by coiling. Although few are sufficiently complete to evaluate with complete confidence, most vessels were probably semi-conoidal or rounded in shape with both conical and rounded bases. A significant amount of morphological variation was, nevertheless, evident. Upper rims were uncollared but frequently thickened, short to medium in height, vertical to slightly outflaring, and mostly flat-lipped. The vessels were generally well made and featured relatively thin wall construction, which generally extends to the base on several reconstructed portions. Incipient castellations were observed on 13 vessels (or 20% of the sample) and at least one shoulder was crenellated. Although the exterior upper rim, neck, and shoulder area was routinely smoothed to accept the decoration, cord-marked surfaces were sometimes incorporated into the motifs, either as a background or an

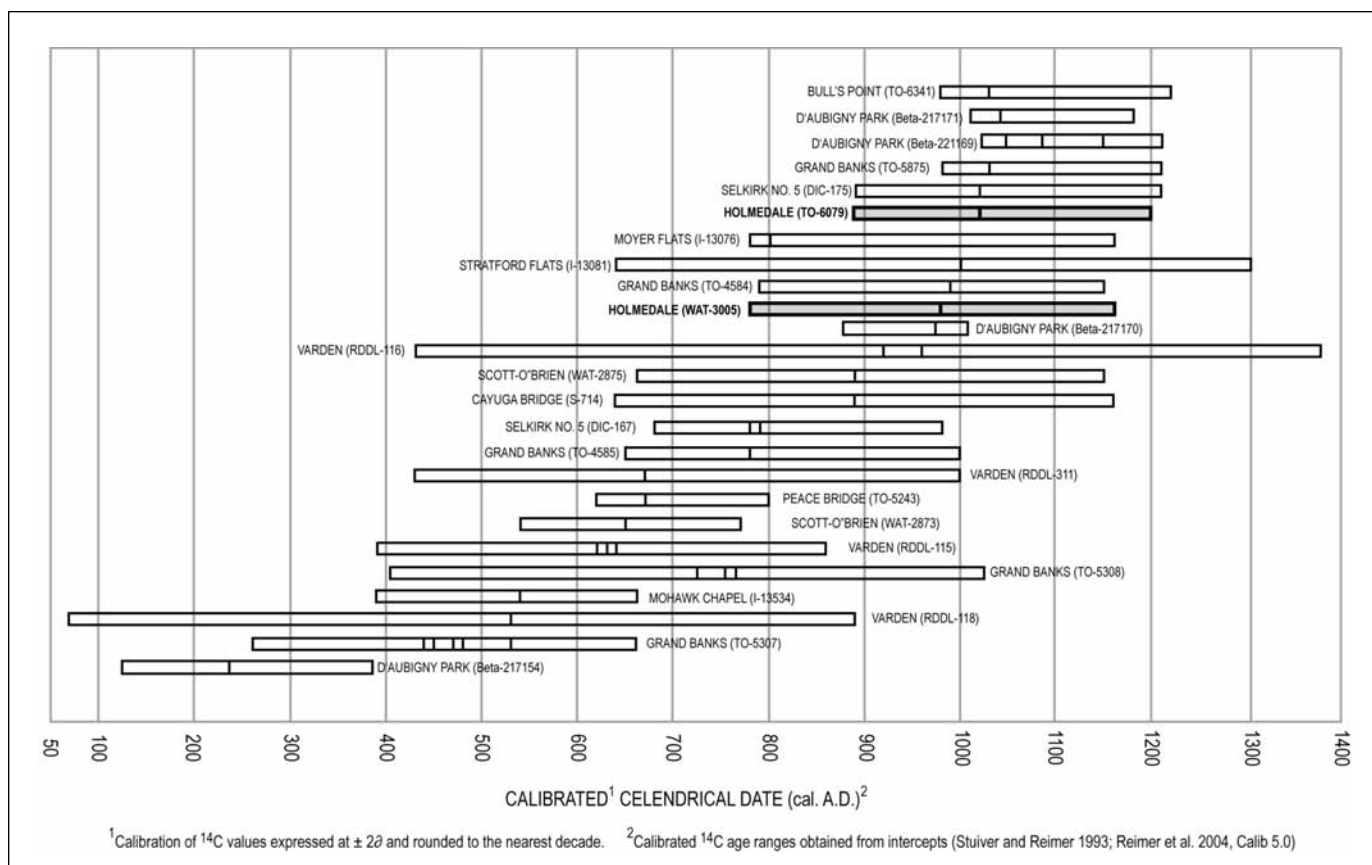


Figure 12-6. The chronological position of the Holmedale site within the radiocarbon sequence for Princess Point Complex sites. Adapted from Smith (1997).

undecorated zone. Surface treatment routinely involved cord-marked paddling, but fabrics were sometimes impressed on the bodies, often immediately below the shoulder.

There was substantial variation within exterior vessel decoration although the key characteristics of the Holmedale ceramic decoration consisted of exterior upper-rim decoration that was limited to one or sometimes two bands of obliques stamped with a cord-wrapped tool; a single row of encircling circular punctates located at the neck (usually raising interior bosses and usually positioned at or near the juncture between decorative zones located on the upper rim and neck-body); and neck-body decoration consisting of one or more horizontal bands of designs, typically stamped with a cord-wrapped implement.

THE HOLMEDALE SITE PLANT REMAINS

The plants remains analysis entailed examination of 35 soil samples derived from 21 archaeological features (Monckton 1999). These samples were processed through

bucket flotation, and plant remains were extracted using a 300 micrometer screen for light fractions, and a 2.00 mm screen for the collection of heavy fractions. Both components were dried in cloth material. In the laboratory, light fractions were weighed and passed through a series of screens to facilitate the sorting of material. Objects larger than 2.00 mm were separated into sample components such as wood charcoal, nut remains, maize kernel fragments and other plant parts in addition to unidentifiable material. Altogether, the samples, which amounted to 166 litres of soil, yielded a total of 14,911 charred plant fragments (Tables 12-1 and 12-2).

Eastern 8-Row, or Eastern Complex, maize (*Zea mays*) and tobacco (*Nicotiana rustica*) were the only cultivated plant taxa identified in the sample. Noncultigens include walnut (*Juglans* spp.), oak (*Quercus* spp.), and hickory (*Carya* spp.) nuts, a wide variety of fleshy fruits and greens. Fleshy fruits are represented by black nightshade (*Solanum nigrum/americanum*), strawberry (*Fragaria* spp.), bramble (*Rubus* spp.), cherry (*Prunus* spp.), hawthorn (*Crataegus* spp.), and grape (*Vitis* spp.). Greens/grains and other taxa include chenopod (*Chenopodium* spp.), cleavers (*Galium* spp.), spikenard (*Aralia nudicaulis*), pep-

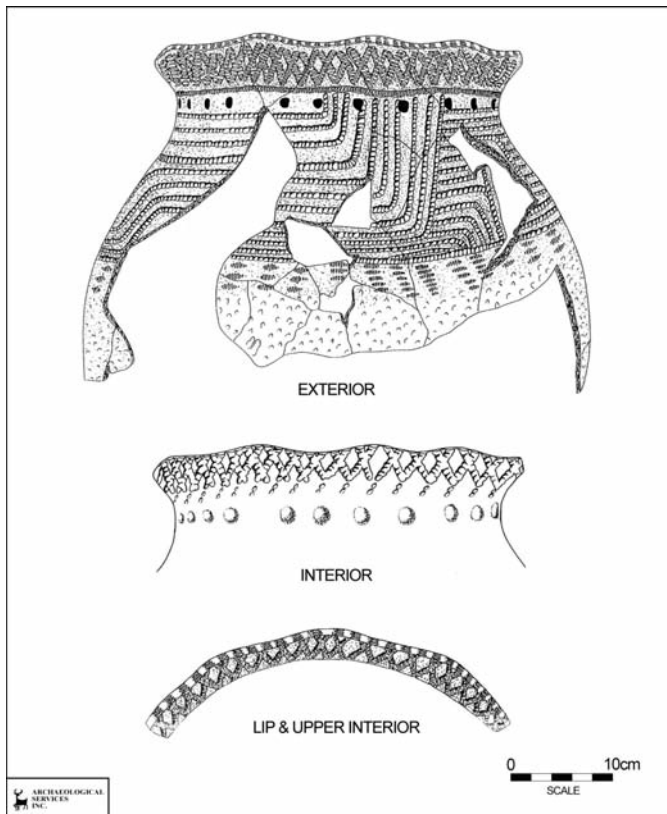


Figure 12-7. Reconstructed ceramic vessel from the Holmedale site.

per-grass (*Lepidium* cf. *L. densiflorum/virginicum*), sumac (*Rhus typhina*), cattail (*Typha latifolia*), small grass (Gramineae), and several unidentified taxa. Wood charcoal fragments represent a familiar range of tree genera for southern Ontario sites. This includes maple (*Acer* spp.), beech (*Fagus grandifolia*), birch (*Betula* spp.), ash (*Fraxinus* spp.), elm (*Ulmus americana*), red and white oak (*Quercus rubra* and *Q. alba*, respectively), and ironwood (*Ostrya virginiana*). Elm and oak are dominant in almost all samples, while ash and ironwood are common contributors.

Fifteen of the 21 proveniences yielded maize in quantities similar to those encountered on later Iroquoian settlements. Although there were several intact maize kernels, the majority of the remains were very fragmented. On the basis of a total weight contribution of 6.5 g, it is estimated that the assemblage represents approximately 70 kernels (based on a sample of 100 intact charred maize kernels from the seventeenth-century Auger site in Simcoe County [Monckton 1992], which weighs approximately 10 g and allowing for some increase in average kernel size through time [Crawford et al. 2006:556; Monckton 1992:30]).

The ubiquity and quantity of maize among the analyzed samples falls within the range of variation seen for

many later Late Woodland and Contact era sites for which data are available (e.g., Monckton 1992, 1998a, 1998b; Ounjian 1998; Robertson et al. 1995), although such comparisons are fraught with potential taphonomic, sampling, and statistical sources of error. On many later Late Woodland sites, for instance, there is a tendency for maize to occur in greater quantities relative to other plant taxa in samples derived from features within houses than from exterior contexts such as middens (Monckton 1998a, 1998b). It is likely unwise, therefore, to use simple ubiquity and frequency data alone to evaluate the corresponding degree of dietary reliance on maize at this or any other point in the archaeological record.

Tobacco (*Nicotiana rustica*) is represented by only eight seeds, although the unidentifiable seed category includes numerous “*Nicotiana*-like” objects, and quantification of this taxon in archaeological assemblages is generally unreliable given the huge number of seeds produced by an individual plant and the uneven representation of seeds among features on most sites (Monckton 1992, 1998a). It is difficult, therefore, to evaluate the degree to which Holmedale inhabitants produced tobacco in comparison with later populations, although the smoking pipe sample recovered from the site is comparatively large, consisting of 17 bowl fragments, seven bowl or elbow fragments, and six stems. Smoking pipes were formerly considered to be rare finds on both Princess Point and succeeding Early Iroquoian sites (Stothers 1977:59; Wright 1966:32). Investigation of a greater number of Early Iroquoian sites has effectively challenged the assumption that pipes were not common (Williamson 1990:299), and it seems likely, based on the frequency of the Holmedale finds and those from the Lone Pine site, where 10 bowls have been recovered (Smith and Crawford 1995:67), that the same holds true for Princess Point, although in neither case do they approach the numbers seen on later Middle Iroquoian sites.

Neither common bean (*Phaseolus vulgaris*) nor cucurbit (*Cucurbita pepo*) remains were recovered from Holmedale, but poor representation of these taxa is typical of even later Iroquoian sites, due to culinary and taphonomic factors that together may not favor preservation in the archaeological record to a degree proportional with their potential dietary significance (Monckton 1992:81, 1998b:118). Bean has a homogeneous and dense cell structure, which can only be recognized if there is sufficient material to suggest its shape. Furthermore, bean was probably soaked in water prior to cooking, lowering the likelihood of accidental charring. Similarly, cucurbit is likely under represented as a result of both its seed structure, and the fact that the preparation of this food did not necessarily entail direct exposure of the seeds to fire. In the seventeenth century, cucurbit was frequently cooked whole in ashes or cut into strips (Thwaites 1896–1901:

Table 12-1. Holmedale site plant remains — sample components.

Feature	Level	Volume (l)	Wood (n)	Charcoal Wt. (g)	Maize (n)	Kernels Wt.(g)	Maize (n)	Cupules Wt. (g)	Walnut (n)	Shell Wt. (g)	Acorn (n)	Shell Wt. (g)	Hickory (n)	Shell Wt. (g)	Unidentified (n)	Nut Wt. (g)	Nut (n)	Meat Wt. (g)	Unidentified Material (n)	Unidentified Material Wt. (g)	Total Fragments	Total Weight
1	fill	5	282	2.84	120	1.38	3	0.01	6	0.18	1	0.01							1	0.01	413	4.43
3	3	2	247	3.72	33	0.3			1	0.01	1	0.01							32	0.09	314	4.13
5	5	3	488	11.7	64	0.85					9	0.01							56	0.2	617	12.76
		5	278	6.22	7	0.07	5	0.01	10	0.14			3	0.01					3	0.01	306	6.46
3	sum	15	1,295	24.48	224	2.6	8	0.02	17	0.33	11	0.03	3	0.01					92	0.31	1,650	27.78
4	fill	4	1575	50.81															1	0.01	1575	50.81
5	3	6																	4	0.01	72	0.43
7A		8	0.42		8	0.05			2	0.01			3	0.01					5	0.01	207	2.01
7B		4	194	1.94	5	0.01			2	0.01			4	0.01					5	0.01	154	2.59
7C		3	138	2.55	10	0.12			267	3.78									10	0.01	406	5.46
		3	119	1.55	23	0.18			271	3.8			7	0.02					15	0.02	767	10.06
8	sum	10	451	6.04	23	0.18													15	0.02	767	10.06
2	2	4	58	0.98	1	0.01	1	0.01	1	0.01	1	0.01			4	0.01			3	0.01	64	1.02
2	2	4	206	2.94	4	0.01	6	0.14	1	0.01									8	0.04	229	3.15
2	2	5	340	4.2	9	0.17	8	0.06	5	0.09					2	0.01			10	0.18	372	4.7
2	2	5	173	2.24			3	0.11							2	0.01			1	0.05	179	2.41
2	2	2	20	0.11	1	0.01													9	0.01	30	0.13
2	2	4	348	6.45	5	0.07	4	0.04	7	0.18	5	0.01			10	0.1			2	0.01	381	6.86
	sum	24	1,145	16.92	19	0.26	22	0.36	14	0.29	6	0.02			16	0.12			33	0.3	1,255	18.27
11		3	94	0.64	3	0.01													6	0.01	103	0.66
18		4	38	0.26															38	0.26	38	0.26
30		7	960	13.92	6	0.1			1	0.01					4	0.01			2	0.01	969	14.04
34		3	6	0.12					1	0.07									1	0.01	126	1.49
44		3	6	0.12															2	0.01	8	0.13
51		5	278	3.77	5	0.01	1	0.01					1	0.01					1	0.01	286	3.81
52		3	545	11.01	21	0.19	2	0.01	1	0.01					6	0.01			2	0.05	577	11.28
53		6	125	1.12	9	0.06			4	0.01	6	0.01			1	0.01			5	0.07	150	1.28
65		3	33	0.35	7	0.01					7	0.06							8	0.15	55	0.57
68		5	307	2.81	8	0.16	3	0.01	1	0.01									10	0.07	329	3.06
		4	132	1.59	12	0.08	2	0.22	6	0.44					1	0.01			5	0.01	158	2.35
	sum	9	439	4.4	20	0.24	5	0.23	7	0.45					1	0.01			15	0.08	487	5.41
69		6	642	45.45	123	1.22	19	0.12	58	1.38			3	0.01	12	0.01	3	0.22	5	0.01	865	48.42
		8	3,900	31.5	8	0.01	2	0.01							1	0.01			11	0.01	3,922	31.54
		9	1,297	33.41	205	2.35	30	0.09	48	1.38	2	0.01			4	0.01			4	0.01	1,590	37.26
	sum	23	5,835	110.36	336	3.58	51	0.22	106	2.76	2	0.01	3	0.01	17	0.03	3	0.22	20	0.03	6,377	117.22
79		9	284	8.29	15	0.17	12	0.09											1	0.01	312	8.56
83		5	66	0.85	6	0.04	2	0.01	9	0.41	15	0.02					2	0.21	9	0.01	109	1.55
84		5	518	3.48			1	0.01			3	0.01							73	0.35	595	3.85
88	1	2	98	1.06	5	0.01			2	0.01											105	1.08
	sum	166	134,463	215.24	592	6.5	90	0.84	402	7.45	52	0.17	11	0.04	37	0.18	5	0.43	288	1.42	14,911	232.23
%			90.18	92.68	3.97	1.18	0.60	0.36	2.7	3.2	0.35	0.05	0.07	0.01	0.25	0.06	0.03	0.13	1.9	0.44	100.00	100.00

Table 12-2. Holmedale site plant remains — seeds.

Feature	Level	Maize	Tobacco	Prunus sp.	Hawthorn	Bramble	Strawberry	Nightshade	Nightshade family	Grape	Sumac	Chenopod	Cleavers	Spikenard	Peppergrass	Small Grass	Sedge	Cattail	Unknown	Unidentified	Total Seeds
1	fill	12		2		2					1	1							2		20
	3	3									4									1	8
	5	9														1				4	15
		1				1						4								4	10
3	sum	25		2		3					5	5				1			2	9	53
4	fill		1																	1	2
5	3																				0
7A		1				1														1	2
7B		1	3			12						2								5	20
7C		2									1									2	6
	sum	4	3			12					1	2						1	1	14	37
8	2			1							1								1	3	5
	2	1				1														1	6
	2	2					1			1	1	2	1							3	11
	2		2										2							5	9
	2	1																		2	3
	2	1																		2	1
	sum	5	2	1		1	1			1	1	2	3						1	14	35
11		1				3														7	11
18						8														3	11
30		1				6		6	1											8	22
34						2														4	6
44						1														4	5
51																				3	3
52		2												1				1		4	4
53		1																		4	5
65		1																		1	2
66		2																	5	7	8
68		1				3						3								1	15
	sum	3				3						3							5	6	10
69		3				1														24	25
		1										10								3	52
		22	1			4		3			3									12	41
		12	1			2		3	1		1									8	
	sum	38	2		1	7		6	1		4	10			2			11	1	45	128
79		2						1				1								3	7
83		1																		1	2
84																					
		1															1		49		50
88		1																		3	4
	sum	85	8	3	1	47	1	13	2	1	11	23	3	2	2	1	1	12	59	126	404
	%	21.04	1.98	0.74	0.25	11.63	0.25	3.22	0.50	0.25	2.72	5.69	0.74	0.49	0.50	0.25	0.25	2.97	14.60	31.19	100.00

15:163, 42:85). In the former case, the soft moist tissue could have provided the seeds with protection from charring while the latter situation suggests that seeds were excluded.

Based on recent research, it does seem clear that bean was not a major crop within the agricultural regime in the Northeast prior to the thirteenth century (Hart et al. 2002). The case for cucurbit is less clear at present, although it has generally been assumed that this cultigen was also a relatively late arrival to southern Ontario and that it did not achieve any major importance prior to the thirteenth century (e.g., Chapdelaine 1993:194; Smith and Crawford 1997:26). Nevertheless, cucurbit phytoliths have been identified in earlier contexts at the HH site, located near the mouth of the Red Hill Creek at the western end of Lake Ontario (Woodley 1996:124). The HH site was primarily occupied during the late Middle Woodland, although a possible Princess Point component also may have been present. No significant later components were identified at the site (Pihl and Williamson 2002; Woodley 1996). The two features from which the cucurbit phytoliths were recovered were AMS dated to 1410 ± 60 B.P. (TO-4270, cal. 2 σ A.D. 530–770) and 1550 ± 60 B.P. (TO-4272, cal. 2 σ A.D. 400–640) (Woodley 1996). The calibrated date ranges suggest that some general assumptions concerning the appearance of this cultigen in southern Ontario, based on the currently available macroscopic evidence alone, may need to be reexamined. The new central New York phytolith data point to the presence of squash in that area ca. 1300 B.C., which is not at all inconsistent with its appearance in other parts of the Great Lakes and Northeast (Hart et al. 2003, 2007; Thompson et al. 2004). Clearly, more research is required in Ontario, but the HH site evidence suggests, minimally, that squash may have arrived at roughly the same time as maize, whether by the same or alternate means.

The plant remains assemblage also indicates that the occupants of the site made extensive use of locally available wild plant foods, specifically nuts and fleshy fruits. Probably the most important collected plant food was walnut whose shell fragments constituted almost half of the food related items larger than 2.00 mm in size. Oak and hickory nuts were present only in trace quantities. There is little doubt that these walnut remains represent food remains rather than fortuitous charring in firewood because there was no walnut wood charcoal present in the analyzed samples. Such food would have been collected in the autumn. Bramble is the most commonly represented fleshy fruit taxon in most southern Ontario Late Woodland archaeological contexts spanning the ca. A.D. 1000–1600 period (Monckton 1992, 1998a; Ounjian 1998), and its strong representation at Holmedale anticipates this pattern. Dietary analysis of the late twelfth-early thir-

teenth-century Myers Road site in Cambridge, located approximately 25 kilometers north of Holmedale, indicates that fleshy fruits such as bramble could have contributed almost half of the daily calories needed by the average person (Monckton 1998a:128). Data presented here show that dependence on fleshy fruits was probably less important than nuts at Holmedale.

Several other taxa also represented at Holmedale could have served as greens or grains. Chenopod (*Chenopodium* spp.) seed is in this category and is represented by a single specimen. It is difficult to evaluate the contribution of chenopod to the diet of the Holmedale site inhabitants, if it was indeed consumed for food. Leaves were probably used for greens, and therefore difficult to quantify on the basis of seeds alone. Pepper-grass (*Lepidium densiflorum*, *L. virginicum*) has been documented for Iroquoian settlements, but its recovery at Holmedale is currently the earliest documented occurrence in Ontario. This member of the Cruciferae could have been used as a green or condiment as the common name implies (Erichsen-Brown 1979:461; Monckton 1992:48). *Lepidium virginicum* is distinguished from *L. densiflorum* by a narrow wing. However, these frequently fail to survive in archaeological specimens, rendering the species indistinguishable. The one specimen that lacks this structure therefore remains identified only to one of these two species. Several other adventive weeds common on Iroquoian sites, but not represented at Holmedale, are knotweed (*Polygonum* spp.), purslane (*Portulaca oleracea*), and several species of small grass (Gramineae).

Other taxa from Holmedale include spikenard (*Aralia nudicaulis*), sumac (*Rhus typhina*), cleavers (*Galium* spp.), and cattail (*Typha latifolia*). All these are quite common in Iroquoian sites. Spikenard, a member of the Araliaceae, was frequently used as medicine in the Great Lakes region (Wrong 1939:195). Cattail seeds occur in several locations at Holmedale and could represent the presence of rush mats similar to those referred to in ethnohistoric records of the seventeenth-century Huron (Thwaites 1896-1901:42:205, 58:209, 59:129, 133, 155). It should be noted, however, that cat-tail seeds are the smallest of identified taxa and can pass through the collection screen, therefore their recovery is probably not systematic. Interpretations of the quantities of cattail should, therefore, be made with caution.

In terms of seasonality, the Holmedale plant remains assemblage strongly supports a late summer to fall occupation. A single strawberry seed was found in a soil sample from one of the large storage pits, possibly reflecting early summer (June) activity. While strawberry could have been dried and consumed in late summer, one might expect more evidence of it in the deposits.

DISCUSSION

As Fox (1990:179) had done some years earlier, Crawford and Smith's research has led them to question certain aspects of Stother's (1977:123–124) original characterization of the Princess Point settlement system, prior to the occupation of the Porteus site toward the end of the sequence, as being essentially unchanged from earlier Middle Woodland patterns; that is, one of large, warm-weather macroband camps situated on river and lakeshores and smaller interior camps, occupied by small groups of related families, during the late fall and winter. Based on their small-scale but highly detailed test excavations at sites such as Grand Banks, which Stothers (1977) had identified as a large, spring-summer riverine bar site, as well as their investigations at Lone Pine and Forster, they are more inclined to believe that these and similar later large sites were formal, more-or-less year-round settlements. They base these interpretations on a number of considerations, including apparent differences in site location choices and parameters between the Middle Woodland and Princess Point along the lower Grand River valley (Dieterman 2001), their discovery that the floodplain river bar locations of some of these sites were stable features during the first millennium A.D. (Crawford et al. 1998; Walker et al. 1997), and on the recovery of dense settlement patterns within their excavation areas (Bursey 2003; Crawford and Smith 2002; Smith and Crawford 1997). The Holmedale settlement patterns are also suggestive in this regard, although the structures are not as formal or well-defined as those reported from the Porteus site. These base settlements, several of which have also yielded evidence of later Early Iroquoian occupation, were complemented by a diverse range of seasonal and special purpose sites located in a variety of geographical settings. These latter small, specialized sites also continued to be of great importance in the subsistence-settlement systems of the Early Iroquoian period.

The introduction of maize in the sixth century, if not earlier, offered yet another, relatively reliable, resource to the late Middle Woodland subsistence repertoire, one which only gradually increased in importance. Smith and Crawford (1997:27) suggest that "Princess Point society was dependent on food production [maize] as a subsistence regime" by the turn of the millennium, based on the apparent increase in frequency of carbonized maize remains on sites of this general date. The basic chronology of this scenario of a gradual increase in maize dependence has found support from Katzenberg's (2006; Harrison and Katzenberg 2003) most recent study of stable isotope chemistry in bone apatite and collagen for pre-Contact southern Ontario populations. She concludes that maize consumption, began by at least A.D. 500 as an

exotic food that was gradually adopted into the subsistence regime. However, it "did not become a dietary staple, when it comprised a sizeable portion of the diet, until approximately A.D. 1000" (Harrison and Katzenberg 2003:241; cf. Katzenberg et al. 1995:341–345). Katzenberg's skeletal sample flanking either side of the ca. A.D. 1000 watershed consists of remains from the ca. A.D. 700 Princess Point Surma component of the Peace Bridge site in Fort Erie at the mouth of the Niagara River, the ca. A.D. 900 Princess Point complex Varden site on Long Point on Lake Erie, the ca. 1150 A.D. Early Iroquoian Miller site in Pickering, and the ca. A.D. 1230–1320 Early Iroquoian Force site on the Grand River.

The disproportionate level of detail available for the Grand River Princess Point components and the diversity of the skeletal sample used in Katzenberg's studies forces one to question whether or not the Grand River developmental pattern and chronology is applicable throughout southern Ontario. Indeed, when viewed from a wider perspective, the role of maize, as either a cause or effect, of a trend toward an increasing degree of sedentism still is not entirely clear. It does seem likely that a greater commitment to maize agriculture would be accompanied by an increasingly sedentary residence pattern, at least for a segment of the community, in order to tend and manage the crops. Yet similar settlement shifts and an increasing degree of sedentism, necessitated by population concentration into regional site clusters, have been proposed for certain Middle and early Late Woodland communities prior to the addition of agriculture to their local subsistence bases (cf. Brashler et al. 2000; Ceci 1990; Ferris 1999; Hart 2001; Hart et al. 2003; Hart and Reith 2002; Wilson 1990; Wymer 1993).

By the same token, the intensification of food production, and its logical consequences, appears to have occurred only gradually throughout most of the remaining portions of southern Ontario during the Early Iroquoian period. The introduction of cultigens did not immediately result in a fully developed Iroquoian cultural pattern as suggested by Snow (1992, 1994, 1995a, 1995b). From what is known in the record, there was relatively little change in the settlement-subsistence strategies of populations from the first appearance of horticultural base settlements in the late tenth century until the late thirteenth and early fourteenth centuries, when it appears that there was sudden and radical change among Iroquoian societies (Kapches 1995; Williamson 1990; Williamson and Robertson 1994).

While maize appears to have been an increasing important dietary component during Early Iroquoian times, its role was still more that of a supplementary nature than a staple. Economic security continued to be sought through diversity (Williamson 1990:312–313). Early Iroquoian

semi-sedentary base settlements or “villages” tended to be small, palisaded compounds with longhouses occupied by either nuclear or, with increasing frequency, extended families. Around these central sites, camps and hamlets served as bases from which to collect wild plants or to hunt game. In southwestern Ontario, investigation of settlement-subsistence practices through time has demonstrated the importance of special-purpose resource extraction camps to the support of a central village. This work has also demonstrated that, initially, these central villages were not occupied by the entire population year round, thereby highlighting how Early Iroquoian settlement was transitional between Middle Woodland and Middle Iroquoian modes (Timmins 1997; Williamson 1985, 1990).

Similarly, Trigger (1976:134) has suggested that with an estimated population of 200 to 400 people, most of the early semi-sedentary villages fall comfortably within the size range of Middle Woodland spring and summer fishing groups, and that the small villages of the Early Iroquoian period may have been continuations of these early macrobands. Their small size also suggests that separate bands had not yet begun to join together to form larger communities and that leadership would have remained informal, perhaps being limited to an individual who also acted as a spokesperson in dealings with neighbouring groups (Trigger 1981:24). Early sedentary villages, therefore, may have been characterized by a flexible and evolving sociopolitical structure, whereby people were free to pursue seasonal subsistence activities in either extended or nuclear family units. Some members of these groups may have elected to remain at fall hunting sites into the winter, depending on the severity of the weather and the availability of resources.

Such overall flexibility would explain the variations in house morphology, interior house activity, and seasonally intermittent occupations at the various exploitative camps documented for Early Iroquoian populations. Until an increasing dependence on cultigens forced a realignment of work tasks which separated men from women for prolonged periods, residence and descent patterns may have remained largely unchanged from Middle Woodland times. The adoption of maize would therefore appear to have been gradual and characterized by conservatism. When horticulture was first practiced, the risk of crop failure may have been great and simple caution may explain the reluctance of Early Iroquoians to engage in full-scale farming (e.g., Bronson 1977:34; Halstead and O’Shea 1989). As long as the size of population aggregates remained relatively small, the natural productivity of some Early Iroquoian micro-environments seems to have encouraged a tendency to reduce risk factors by continuing to rely partially on naturally occurring resources. In this manner, Early Iroquoians sought greater security

through a mixed economy.

There is clear evidence, on the other hand, for a change in economic strategies during the late thirteenth century, although the degree and nature of such change varied among these individual Middle Iroquoian communities. The hamlets and camps of the Early Iroquoian system were to a large degree replaced by agricultural cabin sites, which were situated within the agricultural fields that surrounded the major villages (e.g., Lennox 1995; Pearce 1983; Williamson 1983). While slight increases in house lengths and community size in the preceding centuries may have resulted from internal population growth, these changes in subsistence patterns probably related to the need to produce more maize for more people in one place. It was during this period, too, that the more elaborate sociopolitical systems and infrastructure that are recognizably “Iroquoian” become truly manifest in the archaeological record of southern Ontario. Moreover, it may have been during the late thirteenth century that maize consumption peaked, at least in some localities. Detailed isotope analysis of human remains from the ca. A.D. 1300 Moatfield ossuary, located on a tributary of the Don River approximately five kilometers north of Lake Ontario, indicates that for a brief period, maize comprised 70% of the diet. Such a reliance on a single foodstuff was likely neither sustainable in terms of production effort or desirable in terms of health or risk buffering, but intensified cultivation may have been a necessary, temporary, response to increased population concentration within a newly amalgamated settlement (Pfeiffer and Williamson 2003; van der Merwe et al. 2003). Such levels of maize consumption represent the highest levels recorded for Ontario populations, although it appears to have been related to a single generation of individuals at Moatfield. Analysis of remains from later fourteenth- and fifteenth-century A.D. sites suggest that at its peak, maize typically comprised approximately half of the diet of Iroquoians (Katzenberg et al. 1995; Schwarcz et al. 1985).

CONCLUSIONS

The long period of time involved in the transition to agricultural village life characteristic of the Iroquoian communities of southern Ontario is mirrored by sequences in adjacent areas. In central New York State, for instance, the status of Owasco as the point at which the Iroquoian pattern crystallized has been questioned on a number of grounds. On the one hand, maize was present on some sites by the first century A.D., some 900 years earlier than previously thought, and cucurbit appears to be of even greater antiquity. In several contexts, wild rice also co-occurs with these new cultigens. On the other, neither longhouses nor villages appear prior to the twelfth

century. This disjunction between the presence of cultigens and the appearance of any marked degree of sedentary community patterns, together with reconsiderations of ceramic sequences and their chronology has led many researchers to question the very concept of Owasco (e.g., Hart and Brumbach 2003, 2005; Hart et al. 2003; Thompson et al. 2004). Likewise, the direct relationship between crop husbandry and village life in New England, if indeed there was one, is complex and poorly understood (e.g., Chilton 2002; Hastenstab 1999).

To the west of the Ontario Iroquoians, recently analyzed Younge and/or early Springwells period (ca. A.D. 1100–1300) human remains from Windsor have yielded isotopic evidence of a dietary maize component comparable to fourteenth-century Iroquoians (Henderson et al. 2003) with no clear sign in their archaeological record of any long-standing tradition of village life, or even year-round occupied base settlements, prior to the Springwells phase (Krakker 1983; Murphy and Ferris 1990).

This overall variation is fully consistent with an understanding of sociopolitical organization during the Middle and Late Woodland periods as being characterized by a series of autonomous communities distributed throughout the lower Great Lakes, and with the recognition that there was unlikely to have been a simple, direct, relationship between the adoption of maize and the development of sedentism. The people of the Grand River valley during the second half of the first millennium A.D. represent one or more of these autonomous groups. Even here, in the core area of early agricultural experimentation in southern Ontario, the shift to food production did not bring about an immediate transition to formal village life given the settlement-subsistence patterns evident on this site and other Early Iroquoian sites of the subsequent three centuries. By the late tenth and early eleventh centuries, some four to five hundred years after the initial introduction of maize to the area, sites such as Holmedale, Porteus, Grand Banks and Forster appear to have been more intensively occupied and subject to a greater degree of internal spatial organization, but whether they represent year-round settlements or long-term repeated seasonal occupations remains to be demonstrated conclusively.

The point, or more likely points, at which the other aspects of Late Woodland Iroquoian life that are so intimately associated with the agricultural economic system crystallized within the Grand River drainage, or indeed elsewhere in southern Ontario, remains to be discovered, as do the means by which this shift occurred. With more detailed analyses of other Princess Point sites, it may be possible to begin to reconstruct the actual degree of social and political relatedness between these communities. Investigating these networks, which will require examination of both major base settlements and smaller sites,

will no doubt also contribute to the debate regarding Iroquoian origins and cultural evolution and the role of agriculture in these developments.

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CHAPTER 13
LATE PREHISTORIC PLANT USE
IN THE WESTERN MINAS BASIN AREA, NOVA SCOTIA

by Michael Deal and Sara Halwas

This chapter presents a tentative reconstruction of late prehistoric plant use for the western Minas Basin area of Nova Scotia (Figure 13-1), based on paleoethnobotanical research at four sites spread across the region. The work described here is part of a more comprehensive program that began in the late 1980s (Deal 1990; Godfrey-Smith et al. 1997; Nash et al. 1991). From the beginning, the work was combined with cultural resource management concerns and various kinds of public outreach. The long-term

research objective is to reconstruct late prehistoric land and resource use patterns in the Minas Basin area. To achieve this, the field work component has involved the identification of significant resource locations, and limited sampling of identified sites, in order to acquire information on cultural affiliation and site function. In particular, it is important to the long-term goal to determine the distribution of coastal and interior sites with respect to critical resources, such as lithic raw materials,



Figure 13-1: Study area indicating sites mentioned in text.

shellfish beds, anadromous fish runs, and floral communities. A second goal has been the fine-tuning of the cultural historical timeline within which land and resource use is being interpreted. The cultural resource management component of the program has involved updating the inventory of archaeological sites, including both prehistoric and historic sites (up to the late eighteenth century), and assessing the condition of existing sites, in terms of associated landscapes and evidence of erosion. The latter allows us to assess the completeness of the inventory and to identify sites at immediate risk of destruction due to natural processes (principally coastal erosion) or cultural activities (principally farming).

STUDY AREA

Archaeologists working in the Maritime Provinces generally agree that there was an unbroken cultural sequence from the Middle Woodland to European contact (ca. A.D. 1–1497). When European explorers arrived in the region, the Mi'kmaq (or Micmac) occupied eastern New Brunswick, the Gaspé area of Quebec, and all of Prince Edward Island and Nova Scotia. The Minas Basin is well known as an important area of prehistoric and early historic habitation (Erskine 1975, 1998; Preston 1975, 1991), yet it had received very little archaeological attention before the 1980s. The western portion of the Minas Basin is one of the warmest and most resource-rich areas in the region. It constitutes the northeastern shoreline of Kings County, including Scots Bay and the Blomidon Peninsula, south to the mouth of the Avon River, and incorporating the Cornwallis, Gaspereau, St. Croix, Kennetcook, and Cogmogon river systems. Several prehistoric sites were tested from 1985 to 1990, which gave us a sense of the local cultural timeline and allowed us to identify the most significant habitation and resource locations. Sediment samples collected at some of these sites also provided our first evidence of plant and animal remains used during this period, and gave us an indication of site seasonality.

The late prehistoric inhabitants of the western Minas Basin area were foraging peoples (or hunter-gatherers). According to Kelly (1992:43–44), forager mobility (i.e., the periodic movements of people across the landscape) is influenced by a number of factors, including subsistence, level of food storage, trade, territoriality, social and gender inequalities, work patterns, demography, and cultural perceptions. Following Binford (1980), we can also make a distinction between residential mobility and logistical mobility. The former relates to the movement of all members of a campsite or village from one location to another, while the latter involves the movement of small groups or individuals to and from residential sites (Kelly 1983:278). In logistical terms, mobility can involve short trips for gen-

eral foraging, specific tasks, or resource monitoring.

Two large seasonal village sites have been identified in the western Minas Basin, namely, Melanson (BgDb-7) on the Gaspereau River drainage, and St. Croix (BfDa-1) on the St. Croix River drainage. Several sites in the Melanson area were originally tested by George MacDonald in the 1960s and two decades later by Ronald Nash and Francis Stewart (Nash and Stewart 1990). Melanson and St. Croix are both located at the head of tide of a major river system, in relatively rich resource areas (Nash et al. 1991). Both rivers drain a broad system of interior lakes and both have important spring fish runs. Melanson is also situated close to the extensive outcrops of White Rock quartzite, which was a popular local lithic resource. The St. Croix site was once an ideal fishing spot for Atlantic salmon (*Salmo salar*) and gaspereau (*Alosa pseudoharengus*). The recent construction of a large dam, further up the river, has reduced the water flow on the St. Croix, so that the river no longer attracts these fish. The Ponhook Lake system above St. Croix once served as an important access route to the southern coast of the province (Dawson 1988:135). The dam has backed up water in the Ponhook Lakes and undoubtedly flooded many archaeological sites.

More recent field work has focused on the Clam Cove site (BhDc-1), Scots Bay, and the Toby site (BgDc-12), Starrs Point, at the mouth of the Cornwallis River (Deal 2005a; Halwas 2006). These sites are considered to be logistical campsites. The Scots Bay area is believed to be a marginal environment, where small groups from the Minas Basin visited in the summer and early fall months to quarry stone for local tool production and trade. The relatively isolated and exposed location of Clam Cove, with cool, foggy spring to fall seasons and bitterly cold winters, would have made it unattractive for habitation.

The Cornwallis River is the largest of the rivers in the lowlands south of the Blomidon Peninsula. The river was probably another major occupation and resource area in prehistoric times. Unfortunately, no professional archaeological site survey has been conducted above the mouth of the river, primarily because the area is heavily impacted by modern communities and farming activities. The Toby (or Starrs Point) site was known in historic times as the major Mi'kmaq campsite at the mouth of the river, and location of native shad fishing weirs (PWWI 1977). The site was buried under nearly half a meter of fill during the construction of a dyke in the 1960s.

RECOVERY AND ANALYSIS

Over two decades of fieldwork a variety of recovery techniques have been employed. The Melanson and St. Croix excavations were university field schools, with strict time

Table 13-1. Density (per liter) of seeds recovered from four Minas Basin sites.

Context	Charred	Uncharred	Total/Matrix Volume	Total Density
<i>Melanson (BgDb-7):</i>				
Feature (2N2E)	15	80	95/1	95.0
Feature (6E2N)	180	109	289/5	51.8
Feature (18E2N)	417	45	462/2	231.0
Feature (10E2N)	5	31	36/1	36.0
Site Totals:	617	265	882/9	98.0
<i>Toby (BgDc-12):</i>				
Test Pit 4	1	28	29/2	14.5
Test Pit 5	0	25	26/2.3	11.3
Site Totals:	1	53	54/4.3	12.6
<i>St. Croix (BhDc-1):</i>				
Feature 90-2 (A7)	1	0	1/0.15	6.7
Feature 90-3 (A9, B10)	4	5	9/0.3	30.0
Feature 93-4 (F6 x 2)	2	34	36/0.3	120.0
13 Level 1 Pinch Samples	5	28	33/1.8	18.3
10 Level 2 Pinch Samples	7	18	25/1.5	12.0
3 Level 3 Pinch Samples	0	2	2/0.5	0.9
Site Totals:	19	88	107/4.5	120.0
<i>Clam Cove (BhDc-5):</i>				
Shell-Bearing Deposit	73	2279	2352/19.3	121.9
Non Shell-Bearing Deposit	44	3067	3111/10.5	296.3
Site Totals:	117	5346	5463/29.7	183.9

constraints on what could be accomplished in the field. At Melanson (in 1985) sediment samples were collected from four features; two pit features, a fire-related feature, and a living floor (Table 13-1). Nine one-liter samples were floated on-site in a bucket filled with seven liters of water. The flotage was skimmed off the surface using a tea strainer (1 mm mesh), and hung to dry in cloth pouches. At St. Croix (in 1990 and 1993), pinch samples were collected in small Ziploc bags (200–800 ml) from each level of each unit and from each feature. Samples from three features were included in the paleoethnobotanical study; two living floors and a deep pit feature (Table 13-1). At the field lab, 150 ml samples were floated in .5 liters of water in flat metal trays. Flots were collected and dried on paper towelling. A few samples were dry sieved through a stack of geological sieves (.5–1 mm mesh).

The same techniques were used for the 1989 field season at Clam Cove. In 2005–2006 bulk samples were collected in large Ziploc bags (ca. 2 l) from the shell-bearing deposit at Clam Cove and smaller samples were taken from each level of each non shell-bearing unit. The Archaeology Unit at Memorial University acquired a forced-air flotation machine in 2004, which allows for the processing of larger samples by forced-air or froth flotation (Figure 13-2). The lab also has an IDOT style flotation device, based on a design by Deborah Pearsall (1989: 43ff.), which is used for smaller samples. Our version of the IDOT flotation device consists of an aluminum frame with two U-shaped flanges, which support a .5 mm mesh copper screen. When lowered in a container of water and agitated, three fractions are collected: a flot that is skimmed from the surface, a coarse fraction that collects at the bottom of the screen, and a fine fraction that collects

**Figure 13-2:** Sara Halwas using forced-air/froth flotation machine at the MUN lab.

at the bottom of the container. All four techniques have been used with the Clam Cove samples (i.e., simple flotation, IDOT, forced-air, and froth flotation). Bulk samples were also collected from the cultural level at the Toby site, as revealed by shovel testing. A sample from Test Pit 4 was processed by force-air flotation, while the IDOT device was used for a Test Pit 7 sample.

In each study, identifiable plant specimens were removed from dried flots under a binocular microscope and stored by family or genus in individual gel caps in plastic vials. Species identification was made by compari-

Table 13-2. Density (per liter) of conifer needles recovered from four Minas Basin sites.*

	Melanson (BgDb-7)		Toby (BgDc-12)		St. Croix (BhDc-1)		Clam Cove (BhDc-5)	
	C/U	Density	C/U	Density	C/U	Density	C/U	Density
<i>Abies</i>	38/0	4.2	1/0	0.2	3/118	26.9	0/32	1.1
<i>Juniperus</i>	-	-	-	-	0/9	2.0	-	-
<i>Picea</i>	0/1	0.1	-	-	4/57	13.6	0/206	7.0
<i>Pinus</i>	-	-	-	-	11/63	16.4	-	-
<i>Tsuga</i>	29/0	3.2	-	-	-	-	-	-
Totals (n=578):	67/1	7.6	1/0	0.2	18/253	116.4	0/238	8.1

* C=Charred; U=Uncharred

son with a collection of more than 500 modern species, as well as several seed identification manuals (e.g., Delorit 1970; Martin and Barkley 1961; Montgomery 1977). Checklists of modern flora are also available for portions of the Minas Basin and the entire province (Bromley and Bleakney 1985; Fleming et al. 2000; Roland 1998).

MATERIALS RECOVERED

Flots from the four sites contained a wide range of plant macrofossils, including complete and fragmented seeds, leaves, needles, buds, stems, twigs, roots, charcoal, and sclerotia. Sclerotia were ubiquitous, as they are at many archaeological sites in the Northeast (McWeeney 1989:228). Insect remains, including black and red ants and beetles, were common, as were insect egg cases.

The relatively small recovery rates of macrobotanicals from the samples limits the possibilities of quantification to raw counts (number of individual specimens), raw diversity (number of taxa represented), ubiquity (species presence and absence), and density ratios (seeds or needles per volume or weight of sediment; see Miller 1988). A total of 47.5 liters of sediment were processed from the four sites. Overall, 6,505 seeds were recovered; 928 from features, 2,279 from a shell midden deposit, and 3,226 from level samples (Table 13-1). Total seed density was approximately 137 seeds/liter. Only 753 seeds were charred; 617 specimens from Melanson, 117 from Clam Cove, 19 from St. Croix, and one from the Toby site. The charred seed density was approximately 16 seeds/liter.

Identified plant remains also included 578 conifer needles, of which only 86 (9.7%) were charred (Table 13-2). Like the charred seeds, most of these were recovered from a fire-related feature and living floor at Melanson. Charred needle density was 7.6 needles/liter for Melanson, while only uncharred specimens were recovered at Clam Cove (8 needles/liter). Uncharred needles were widely distributed within level samples at St. Croix and Clam Cove. Charcoal fragments were also widely dispersed at these two sites. Charcoal was routinely collected during each excavation for the purposes of radio-

**Figure 13-3:** Charring experiment at Clam Cove in 2005.

carbon dating. Halwas (2006) analyzed 110 samples from St. Croix and Clam Cove (Table 13-3). Since we lacked a comparative collection of charred wood samples, an experimental charring exercise was conducted at Clam Cove in 2005. Branches from each of the tree species represented at the site were collected and charred in an open fireplace (Figure 13-3). These were taken back to the lab and used as a comparative collection.

Halwas (2006) argued that many of the uncharred specimens from the Clam Cove shell midden deposit should be considered ancient due to the preservation of many uncharred faunal specimens in the midden. The exceptional preservation of plant remains in shell midden deposits has been noted in other recent studies (Miksicek 1987). However, for the purposes of our discussion of plant use, only charred specimens from the four sites are considered to date to the time of site occupation (see Minnis 1981).

ETHNOHISTORIC AND ETHNOGRAPHIC EVIDENCE

Quinn (1981:2–3) notes that despite regular visits by fishing vessels to the shores of the Maritime Provinces, we

have virtually no information on the Mi'kmaq until one or two generations after initial contact. Quinn attributes this largely to the secrecy surrounding access to the fishing grounds in the New World (1981:4). Chroniclers of the sixteenth century left us with only vague references to the use of birch bark canoes and people living on fish, flesh and fruits of the trees. While many aspects of their culture had already been altered due to a century of trade with the Europeans (Whitehead 1991), the Mi'kmaq were still largely living a hunting-gathering lifestyle. Once settlement started in earnest, at the beginning of the seventeenth century, we began to get scattered entries on Mi'kmaq plant use. Often these early descriptions have clear links to later ethnographic observations, but sometimes the plants are misidentified or the modern species has not been determined (Erichsen-Brown 1979; Ganong 1909). Treated with caution, they are still a valuable source of analogy for interpreting prehistoric plant use (see Table 13-3).

The earliest reliable evidence of Mi'kmaq plant use comes from Marc Lescarbot, a French lawyer and scholar who assisted with Sieur Du Gua de Monts' fur trading enterprise at Port Royal (1606–1607). Lescarbot's (1914) *Histoire de la Nouvelle-France* ends with his observations on Mi'kmaq culture (known to him as the Souriquois), which includes a number of general and specific records of plant use. A Jesuit priest, Pierre Biard, arrived at Port Royal on May 22, 1611, to conduct missionary work among the Mi'kmaq, and stayed until 1614. Although his work in Acadia was largely unsuccessful, his *Relation de Nouvelle-France* (Biard 1896) provided some additional information on native customs and references to plant use.

The most useful early report to include references to Mi'kmaq plant use was penned by Nicolas Denys, an energetic merchant-fisherman, who encouraged settlement in Acadia in the mid-seventeenth century. Denys established posts at Miscou, Nipisiquit, Saint-Pierre, and

Chedabouctou, and conducted logging and fishing operations in the Gulf of St. Lawrence area. However, he is best known for his *Description Géographique et Historique des Costes de l'Amérique Septentrionale: avec l'Histoire Naturelle du Païs* (Denys 1908), which he wrote after his retirement and published in 1672. In 1675 a Recollet priest, Chrestien Le Clercq, was appointed as a missionary to the Mi'kmaq of Gaspé (whom he called Gaspésiens). Le Clercq became very attached to this group and remained in the area until 1686. In 1691 he published an account of his experience in the *Nouvelle Relation de la Gaspésie* (Le Clercq 1910), which focused on the Mi'kmaq and offered more examples of plant use.

The last significant seventeenth-century chronicler is Dière de Dièreville, a French surgeon and writer, who came to Port Royal in 1699 as a supercargo (an agent hired by a shipowner to oversee the cargo). He spent a year in Acadia collecting information on the European and native populations, as well as collecting plants. The name Dièreville appears on the labels of 25 plant specimens in the herbarium of the Muséum d'Histoire Naturelle in Paris. The account of his trip to Acadia, *Relation du Voyage du Port Royal de l'Acadia, ou de la Nouvelle France* (Dièreville 1933), includes information on the customs of the Mi'kmaq and methods of food preparation.

The first significant Mi'kmaq scholar of the modern era is Silas T. Rand, a Baptist clergyman and philologist, who had a lifelong association with the Mi'kmaq of Nova Scotia. In 1846 he began a study of their language in an effort to communicate his religious beliefs and seek converts to Protestantism. From an ethnobotanical perspective, Rand's (1888) most enduring contribution was his *Dictionary of the Language of the Micmac Indians*, which includes many plant names and terms related to plant use (see Table 13-4). He also collected and translated traditional Mi'kmaq place-names, including some locations were plant resources were collected. These were later compiled by William Anderson (Rand 1919).

In the early twentieth century, ethnobotanical observations were made among the modern Mi'kmaq by trained botanists and ethnographers. In particular, Wilson Wallis conducted ethnographic field work throughout the Maritime Provinces between 1911 and 1912, and returned with his wife Ruth Sawtell Wallis to do a restudy in 1950 and 1953. This research contributed much detailed information on plants used for food and medicine, and included a list of about 70 botanical terms (Wallis 1922; Wallis and Wallis 1955). The original research was encouraged by Frank Speck, who had conducted ethnological field work throughout the Eastern Woodlands, including a trip to the Mi'kmaq area in 1914 (Speck 1915). Speck, along with Ralph Dexter, revisited the Mi'kmaq and Maliseet (or Malicite) areas of New Brunswick in 1949 to collect additional information on plant and animal exploitation

Table 13-3. Number of identified charcoal specimens from two Minas Basin sites (after Halwas 2006).

	St. Croix) (BfDa-1)	Clam Cove (BhDc-5)	Totals:
SOFTWOODS:			
<i>Abies</i> (Fir)	3	12	15
<i>Picea</i> (Spruce)	29	7	36
Unidentified	4	4	8
Totals:	36	23	59
HARDWOODS:			
<i>Acer</i> (Maple)	0	13	13
<i>Alnus</i> (Alder)	0	2	2
<i>Betula</i> (Birch)	3	12	15
<i>Fagus</i> (Beech)	0	15	15
<i>Populus</i> (Poplar)	0	2	2
UNIDENTIFIED	0	4	4
Totals:	3	48	51
Grand Totals:	39	71	110
(7 species)			

Table 13-4. Uses of identified plant specimens suggested by ethnohistoric observations.*

Scientific (Common) Name	Source(s)	Plant Use
<i>Abies balsamea</i> (balsam fir)	De, Le	Gum used to seal canoe
	De	Gum chewed to whiten teeth
	De	Gum chewed to prevent toothache
	Le	Gum used a poultice for sores/cuts
<i>Abies</i> spp. (firs)	Di	Bark used in wigwam construction
	De, LC, Bi	Branches used a bedding
	De, Le	Roots used as thread to sew bark
	LC	Bark used as burial shroud
	Di	Needles steamed as olfactory stimulant
<i>Acer</i> spp. (maples)	De	Wood used to make bows
	Le	Bark eaten in time of famine
<i>Betula papyrifera</i> (paper birch)	De, LC, Di	Bark used as wigwam cover
	De, Bi	Bark used as canoe cover
	De	Bark used to make hunting torches
<i>Betula</i> spp. (birches)	De	Bark used to bait rabbit traps
	De	Bark used as funeral bier and coffin
	Di	Bark used as splints and bandages
<i>Fagus</i> spp. (beeches)	De	Wood used as snowshoe frame
	De	Wood used as canoe frame
	De, Bi	Wood used as canoe paddles
	De	Wood used as spear shaft
<i>Populus</i> spp. (popular)	Di**	Bark used to bait beaver traps
<i>Quercus rubra</i> (red oak)	Bi	Acorns shelled and eaten

*Sources: Bi=Biard 1896; De=Denys 1908; Di=Dièreville 1933; LC=Lescarbot 1928; Le=Le Clercq 1910.

** Dièreville 1933 refers to the local poplar as aspen (p. 134, note 1).

(Speck and Dexter 1951, 1952). Cyrus McMillan also conducted ethnographic investigations throughout the Mi'kmaq area between 1911 and 1913 under the auspices of the Division of Anthropology of the Geological Survey of Canada. His unpublished manuscript provided an additional list of 33 terms related to plants and berries used by the Mi'kmaq (McMillan 1914).

The modern ethnobotanical information can also be problematical for paleoethnobotanical interpretation, in that the Mi'kmaq had adopted many European plant uses since the early contact period. However, the extensive use of plant materials for food, medicine and tools documented for the historic population does indicate that we have a great deal more to learn about plant use in the pre-historic period (see Table 13-5). To date, less than 50 plant species have been identified from archaeological samples from the Maritime Provinces (Deal 2008).

When we compare the list of identified plants from the Minas Basin sites with the available ethnohistoric evidence (Table 13-4), we see that most of the overlap is with tree species (i.e., various species of fir, maple, birch, beech, and popular). Many other species are mentioned by the early chroniclers, but they have not yet been identified in the study area. When we consider the modern linguistic evidence, we see that each identified species (or genus) is accounted for (Table 13-5). When we consider the modern ethnographic evidence, the identifications are more numerous and accurate (Table 13-6). In the following discussion, a direct historic approach is used to interpret the possible plant use at the Minas Basin sites, in which all of

these sources are considered, with greater weight being placed on the ethnohistoric evidence.

DISCUSSION

Plant use can be summarized under four basic categories, namely, plant foods, medicines, fuel woods and construction materials, and textiles. Textiles have been identified at a few protohistoric Mi'kmaq sites, but none in the study area (Deal 2008; Whitehead 1987). Plant foods can be further divided into edible fruits, nuts, roots, and tubers. Several of the identified charred specimens are believed to be present as natural vegetation on prehistoric sites and may not have had economic value, including *Carex* spp. (sedges), *Rumex* spp. (docks), *Eleocharis* sp. (spike rush), *Polygonum* spp. (smartweed), *Potamogeton* spp. (pondweed), *Stellaria* spp. (chickweed), *Echinochloa crusgalli* (barn grass), and *Ruppia maritima* (ditchgrass).

Plant Foods

Several common plant species bearing edible fruits have been recovered at the Minas Basin sites (Table 13-6). These include pin cherry and black cherry (*Prunus* spp.), raspberry and/or blackberry (*Rubus* spp.), blueberry (*Vaccinium angustifolium*), bunchberry (*Cornus canadensis*), cranberry (*Viburnum* spp.), chokeberry (*Aronia* spp.), mountain ash (*Sorbus americana*), elderberry (*Sambucus canadensis*), staghorn sumac (*Rhus typhina*), and crab apple (*Pyrus* spp.). Several species are mentioned by early

Table 13-5. Selected Mi'kmaq terms associated with identified plant specimens.

Scientific (Common) Name	Mi'kmaq Terms (Source*)
<i>Abies balsamea</i> (balsam fir)	upkoo; amakeinsoode (R); stokum (M)
<i>Acer saccharum</i> (sugar maple)	sunow (R); suawi (WW); keokchemoose (M)
<i>Alunus</i> sp. (alder)	toobe (R)
<i>Betula papyrifera</i> (white birch)	maskweel (R); maskwi (WW)
<i>Betula</i> sp. (birch)	maskwe; saoopogeachk (R); maskwe (M)
<i>Fagus</i> sp. (beech)	soomoosel (R); suomosi (WW); soomoose (M)
<i>Nasturtium officinale</i> (watercress)	kajooemachkul (R)
<i>Picea glauca</i> (white spruce)	ukchigumootkwook (R); kawak (WW)
<i>Picea mariana</i> (black spruce)	ulnatkw (R); kawak (WW); Ulnatk (M)
<i>Pinus strobes</i> (white pine)	gooo; gooak (R); gooa (M)
<i>Populus</i> spp. (poplar)	medeek (R); midi (WW); mede (M)
<i>Prunus</i> spp. (cherry)	maskwaseman; looeman (R); maswesinaan (WW); maskaseman (M)
<i>Prunus serotina</i> (black cherry)	wagwonumink (R);
<i>Malus</i> sp. (apple)	wenjoosoon (R); wendjusun (WW)
<i>Quercus</i> spp. (oak)	mimkwonmooseel (R); mimkwonmoose (M)
<i>Rhus typhina</i> (staghorn sumac)	ketakunemoosel (R); kidaanamusi (WW)
<i>Rubus</i> sp. (blackberry)	ajeokchemin (R); winoman (WW); ajeogchemin (M)
<i>Rubus</i> sp. (raspberry)	kuledow (R, M); kalidak; klidomusi (WW)
<i>Sambucus canadensis</i> (elderberry)	poogoolooskwemanul (R); poogoolooskwemoose (M)
<i>Tsuga canadensis</i> (hemlock)	uksooskuk (R); iksusk (WW)
<i>Vaccinium angustifolium</i> (blueberry)	upkweman (R, M); epkuman (WW)
<i>Viburnum</i> sp. (cranberry)	soon; nibuman (R); nootkajeman (R, M); sunaksis (WW)

*Sources: R=Rand 1888; M=Macmillan 1914:388–391; WW=Wallis and Wallis 1955:502–504.

Table 13-6. Modern Mi'kmaq uses for identified plant specimens.

Scientific (Common) Name	Mi'kmaq Uses (Source*)
<i>Abies</i> spp. (firs)	Wood for brooms, bows, wigwam poles; branches as floor covering, bark to make black dye (WW)
<i>Abies balsamea</i> (balsam fir)	Inner bark or tip for medicine and beverage (S, WW); olfactory stimulant (W)
<i>Acer</i> spp. (maples)	Wood for spoons, bows, gaming bowls, coat pins, eel smoking stick; sled runners; bark to make purple dye; tips for tea (WW); bark for tea (S)
<i>Acer saccharum</i> (sugar maple)	Sap for making sugar and syrup, bark for tea (S); olfactory stimulant (W)
<i>Alunus</i> sp. (alder)	Bark for medicine or poultice (W)
<i>Betula</i> sp. (birch)	Wood for center wigwam pole, bows, fibers for cord, for smoking fish; bark for containers, smoking pipes, rattles, trumpets, and drums, mats, raincoats, hats, canoe cover and sail, wigwam cover, torches for night hunting, moose calls, beaver trap bait, maps and messages, burial shroud; branches to hang pots, fish nets, snares; twigs for tea (WW); bark for tea (S)
<i>Fagus</i> sp. (beech)	Wood used for sled runners (WW)
<i>Fagus grandifolia</i> (beech)	Nuts eaten (WW)
<i>Picea</i> spp. (spruce)	Wood for wigwam poles, fish racks, canoe support, young tree for sail; splits for baskets; roots for thread, cord, snares; gum for canoe seal (WW); olfactory stimulant WW)
<i>Picea glauca</i> (white spruce)	Bark for beverage or medicine (S), poultice (W)
<i>Picea mariana</i> (black spruce)	Bark for beverage or medicine (S, W)
<i>Pinus</i> spp. (pine)	Punk used to rub hides in tanning; sap for canoe seal; bark and root for green dye (WW)
<i>Pinus strobus</i> (white pine)	Inner bark grated and eaten; bark, tips, twigs for beverage or medicine (S, W), poultice (W)
<i>Prunus</i> spp. (cherry)	Fruits eaten (S)
<i>Prunus serotina</i> (black cherry)	Bark used to make medicine for lungs (W)
<i>Quercus</i> spp. (oak)	Punk used to rub hides in tanning (WW)
<i>Quercus alba</i> (white oak)	Acorns eaten (S)
<i>Rhus typhina</i> (staghorn sumac)	Medicine for sore throat (W)
<i>Rubus idaeus</i> (raspberry)	Berries eaten fresh or dried (S)
<i>Rubus canadensis</i> (blackberry)	Berries eaten fresh or preserved (S)
<i>Sambucus canadensis</i> (elderberry)	Berries eaten fresh or dried (S)
<i>Tsuga</i> spp. (hemlock)	Branches for olfactory stimulant; root for red dye (WW)
<i>Tsuga canadensis</i> (hemlock)	Leaves or bark for beverage or medicine for lungs (S, WW)
<i>Vaccinium</i> spp. (blueberry)	Berries eaten fresh or dried (S), or made into cakes (WW)
<i>Viburnum</i> sp. (cranberry)	Berries eaten fresh or used in preserves (S); medicinal tea (W)

*Sources: S=Speck and Dexter 1951; W=Wallis 1922; WW=Wallis and Wallis 1955:502–504.

explorers, although little information is offered on their uses. All of the identified specimens are known from the Mi'kmaq vocabularies and are also included among the many species used by the modern Mi'kmaq (Table 13-6). Some species, such as raspberry and elderberry, were often dried and stored for winter consumption (Speck and Dexter 1951:257). A few other identified species have edible plant parts, including *Chenopodium album* (goose-foot), *Nasturtium officinale* (watercress), *Oxalis* spp. (sorrels), and *Rhus typhina* (staghorn sumac). Maple bark was identified as a famine food by Lescarbot (1914:225).

Although it has yet to be identified in the Minas Basin area, groundnut (*Apios americana* Medic.) tubers were an important food resource for the Mi'kmaq in the early historic literature (Biard 1896:3:259; Denys 1908:2:398). Shubenacadie, just to the east of the Minas Basin, takes its name from the Mi'kmaq term Segebunakade, meaning "place where groundnut abounds," while Isle Haute, at the outlet of Minas Basin, gets its Mi'kmaq name ("Maskusetkik") from another edible root ("maskuset"; Rand 1919:44, 73). Groundnut tubers continued to be used by both the Mi'kmaq and Maliseet into the modern era (Speck and Dexter 1951, 1952; Wallis and Wallis 1955). Groundnut tubers have been recovered elsewhere in the Mi'kmaq region, as well as coastal Maine (Ash Sidell 1999:206; Leonard 1996:144–152).

Nut kernels have been an important food source in eastern North America since Archaic times. Woodland and Protohistoric sites in New Brunswick have yielded specimens of butternut (*Juglans cinerea* L.), hazelnut (*Corylus cornuta*), beechnut (*Fagus grandifolia*), and acorn (*Quercus* spp.). These species have also been recovered from prehistoric contexts in Maine (Asch Sidell 1999:205–206). Of these species, only acorns were recovered in the study area, and only at the St. Croix site. Charred acorns were recently recovered from a Late Woodland deposit at McKibbin's Beach (BdDi-07), on the Allains River/Mersey River portage route in southwestern Nova Scotia (Pentz 2007). Beech wood was identified among the charcoal samples. Nuts do not receive much attention in the ethnohistoric literature for the area, although Biard (1896:3:108) does mention that the Mi'kmaq shelled and ate acorns. All of these nuts are listed as foodstuffs of modern Mi'kmaq (Speck and Dexter 1951). Wallis and Wallis (1955:66) noted that the early twentieth century Mi'kmaq enjoyed beechnuts, which they often robbed from chipmunk stores.

Medicinal Plants

The majority of plant species utilized by modern northeastern Algonquian groups were used for medicinal purposes (Table 13-6). For example, Chandler et al. (1979:52) report that the Mi'kmaq used at least 128 different species to treat about 70 ailments (also see Arnason et al. 1981).

Unfortunately, very little evidence survives in the archaeological record or in the reports of early chroniclers. Lescarbot (1914:172) noted that Mi'kmaq shamans carried around a bag full of herbs and drugs. Macmillan (1914:52) describes certain roots that were still being collected in the autumn for medicinal purposes. Biard (1896:3:117) reports that medicines consisted of "a few simple laxatives of astringents, lenitives or liver and kidney irritants." Diéreville (1933:176) reports on the use of fir branches in steambaths as olfactory stimulants. Modern ethnographers also record the use of fir and spruce needles, as well as the bark of hemlock, sugar maple, and black cherry for this purpose (Table 13-6). Denys (1908:2:415) and Le Clercq (1910:298) report that roots and herbs, of types unknown to Europeans, were used to treat injuries. Balsam fir resin was used to cure sores and cuts, either chewed and spat on the wound or used in a poultice. Fir and spruce gum were also identified as having medicinal properties (Lescarbot 1914:305). Of the plants represented by charred specimens at Minas Basin sites, several have known medicinal properties, and their parts (fruits, leaves, roots, needles, or runners) were used in modern times to make herbal teas, and a number of tree species were used to make salves and poultices. Bandages and splints to treat injuries were made from birch bark and wood (Diéreville 1933:177).

Fuel Wood and Construction Materials

Several of the identified specimens represent tree species that were used as fuel woods and construction materials. Halwas (2006) identified 59 softwood specimens and 51 hardwood specimens in the charcoal samples from St. Croix and Clam Cove. The softwoods included *Abies* (fir) and *Picea* (spruce) species, while the hardwoods included species of *Acer* (maple), *Alnus* (alder), *Betula* (birch), *Fagus* (beech), and *Populus* (poplar). Other tree species were identified by the presence of charred needles or seeds, namely, *Pinus strobus* (white pine), *Quercus rubra* (red oak), and *Tsuga canadensis* (hemlock). Monckton (2000) conducted a similar analysis of charred wood fragments from the Woodland Period Meadows site, New Brunswick. Eight taxa were identified among the 352 fragments, while an additional 115 fragments were classed as deciduous. The most likely source of charred wood fragments at all of these sites is aboriginal cooking fires.

Monckton's analysis suggests that hardwoods, such as maple, ash, and birch were preferred fuel woods. These woods burn longer and produce more heat. Conifers, such as pine (*Pinus* spp.), balsam fir (*Abies balsamea*), hemlock (*Tsuga canadensis*), and spruce (*Picea* spp.) burn more quickly. These woods would be more important at coastal and island sites where hardwoods are in limited supply. Halwas (2006:57) suggests that the preference for hardwoods at Clam Cove may indicate a late summer to fall

use of the campsite. The temperatures at Clam Cove tend to be 10°C cooler than those in Minas Basin proper. She also suggests that the preference for softwoods at St. Croix may indicate a summer occupation, when heating demands are less. Charred conifer needles recovered from prehistoric sites in the region may also be from fuel woods, or from boughs used as bedding or floor coverings near hearths (Biard 1896:77; Diéreville 1933:423; Lescarbot 1914:102).

The wood of hardwoods in general could also be used as firewood, construction materials, and tool hafts. The selection of wood for tool hafts may have been more important to the user than the stone elements of tools, since they often take longer to make and are used for longer periods (Keeley 1982). Denys (1908:419) reports that maple wood was used for bows. Ethnographic sources record many more uses of hardwoods, including wigwam poles, sled runners, spoons, clothing pins and gaming pieces (Table 13-6). One sixteenth-century chronicler (Richard Fisher, 1593) noted that the Mi'kmaq of Cape Breton used oak spits for roasting meat (Quinn 1981:47). Birch was a particularly important species since its bark was used for making wigwams, canoes, containers, and burial shrouds. Birchbark containers have also been used in the Northeast for at least 2,000 years (Petersen et al. 1994:211–212). Birchbark fragments have been recovered from burial sites dating from the Early Woodland to the historic period. Birchbark was also used to make torches for night hunting, to make moose calls, and as bait in rabbit traps (Denys 1980:389, 420). According to Diéreville (1933:134) poplar bark was also used to bait beaver traps. Bark from several tree species were probably also used to make dyes, as in modern times (Table 13-6).

CONCLUSIONS

Paleoethnobotanical research has been slow to develop in the Maritime Provinces (Crawford 1999; Deal 2002b), but archaeologists are now routinely collecting samples for analysis. Poor preservation conditions have meant low recovery rates and a bias toward seeds with thicker coats, and nuts (Deal 2008). Moreover, most seeds are recovered as charred specimens from fire-related features. Wood charcoal is abundant, but underutilized as a source of information. The present interpretation of plant use relies heavily on corroborative evidence from the writings of early chroniclers and from the modern ethnographic studies. Although there is much more work to be done, we are beginning to get a glimpse at the diversity of prehistoric plant use in the Minas Basin region.

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CHAPTER 14

MAIZE AGRICULTURE IN THE COLONIAL PERIOD: A VIEW FROM MOHEGAN

by Jeffrey C. Bendremer and Elaine L. Thomas

"Growing a three-sisters garden together was a way to keep in tune with our traditional values . . . a way to bring us closer to the earth."

—Chairman, Mohegan Council of Elders 2006

"Planting corn renews our covenant with the earth. When we harvest, we think of the creator and we are grateful Mother Earth has provided for us . . ."

—Mohegan Tribal Member 2006

Corn¹ has a special place in the hearts of contemporary Mohegan tribal members. Representing a palpable connection to the past, maize is a communal bond to tribal ancestors, recognition of their labor and ingenuity and a link to the Mohegan ancestral homeland. Material culture associated with corn such as mortars, pestles, and hoes are cherished by Mohegan families. Maize agriculture, therefore, represents an important dimension of Mohegan identity and culture today as well as a link to the past.

The contemporary Mohegan relationship with corn is best exemplified by the "Three Sisters Garden," an agricultural project sponsored by the tribe since 1997. The garden has given the tribal community an opportunity to gather and undertake planting, cultivating, and harvesting corn, beans, squash, and tobacco, employing traditional mound culture techniques. The products of the garden are used to make Native dishes such as succotash and yokeag (also known elsewhere as nocake or nokehick). In addition, associated crafts, such as corn husk dolls and mat making, have been revived as a direct result of the garden project.

The origins of maize agriculture and traditional agricultural practices are of great interest to tribal members. Our research, now in its early stages, aims to explore the role of agriculture in Mohegan life from pre-European Contact times to the present. Information from over 10 years of excavations as well as collections now curated by

the tribe are being examined to help tell this story. It should be noted that, despite the special significance of corn and the "three sisters," it is equally important to the tribe that we develop a greater understanding of the role of agriculture in the overall subsistence system, the tribe's bond with the land and the dynamic ways that the Mohegan people have related to their environment.

"Corn gives life, it is the continuation of life, sustains life, it is part of the circle of life. If I didn't plant corn, I would be severing my ties to the past."

"I have an old mortar and pestle passed down in my family from woman to woman . . . for generations."

—Mohegan Tribal Members 2006

MAIZE AGRICULTURE IN EASTERN CONNECTICUT

Pre-European Contact

Prior to the time of European Contact, the exact role of tropical cultigens in the overall subsistence system varied in different areas of eastern Connecticut (Bendremer 1993). For example, corn appeared to be more important in the middle Connecticut River valley than in the lower Connecticut River valley, coastal areas, the uplands, or Block Island (Bendremer 1993; Bendremer and Dewar 1994; Bernstein 1992a, 1992b; Lavin 1988). This is not to say that even in the middle Connecticut River Valley corn was a "staple" food, providing the bulk of the caloric intake, as may have been the case later; but it was a significant food resource, nevertheless, whose cultivation would have required some accommodation in scheduling, settlement, and subsistence strategy.

The Burnham-Shepard site in South Windsor (Bendremer 1993; Bendremer et al. 1991) and the Morgan site in

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Rocky Hill (Lavin 1988) exemplify a class of semi-sedentary, agricultural, Late Woodland (ca. A.D. 1000–1500) hamlets found in the middle Connecticut River valley. Larger, contemporaneous, and perhaps even more sedentary coastal sites like Mago Point in Niantic (McBride and Dewar 1987) exhibited a subsistence system oriented to marine and estuary resources with little evidence of maize agriculture. In addition to varying degrees of agricultural intensity, broad-based exploitation of local wild animal and plant resources rounded off the subsistence system. After European Contact, presumably by the early seventeenth century, maize, beans, and squash take on more importance (Ceci 1979–80). It is interesting to note that in 1622 Bradford (1987:114) implies just such a shift toward agriculture in eastern Massachusetts, “for they set but little (corn and beans) till they got English hoes.”

Mohegan Subsistence in the Seventeenth Century

By the early seventeenth century, there were some substantial changes in the settlement and subsistence system in southern New England. By the time that European chroniclers were recording their observations of Native life, corn, beans, and squash appear to constitute a significant food resource across the region (Bradford 1987; Gookin 1970; Josselyn 1988; Morton 1937; Mourt 1963; Williams 1963; Wood 1977), representing a significant departure from pre-Contact subsistence patterns, particularly in coastal areas.

These changes have been attributed to the appearance of Europeans in southern New England (Ceci 1979–80). It is true that Europeans provided a source of trade goods, particularly metal and glass objects, which were in high demand by Native people (Salwen 1966). For example, by 1634, Wood (1977:86) implies that in the area around Massachusetts Bay Colony, Native earthenware used for cooking had been substantially replaced by the use of iron kettles, “traded for with the French long since, and do still buy from the English as their need requires.” In fact, *Indian corn* itself became a trade commodity well before the Pequot War in 1637, according to Higginson (1950:72). However, despite Bradford’s (1987) implication that the availability of metal implements was the catalyst for increased agricultural production, we feel this was only coincidental to a suite of social and economic shifts that occurred by the early seventeenth century.

As opportunities for trade increased, the shell-bead manufacturing industry intensified and wampum took on the role of a medium of exchange. The demand for access to European goods and the rapidly increasing strategic importance of shellfish beds for wampum manufacturing resulted in an increased degree of territoriality in southern New England, which in turn escalated intertribal hostilities. Increased warfare, combined with catastrophic European-borne diseases resulted in population

decline and population consolidation, increased political centralization and the fortification of large, sedentary village sites which, according to our best knowledge, did not exist before contact in this area. Intensification of maize agriculture was an important adaptation to support these fortified village sites. This more nucleated settlement strategy has been aptly described as “tethered mobility,” referring to how Native people were tied to their corn fields even as they seasonally exploited other natural resources (Heckenburger et. al. 1992).

SHANTOK: VILLAGE OF UNCAS

Fort Shantok, a National Historic Landmark, was the principle village of Uncas, the progenitor of the Mohegan Tribe. After splitting off from the Pequots just before the Pequot War, Uncas returned to the lands of his father Oweneco, and founded or reoccupied Shantok in about 1635. He chose to locate his village on a highly defensible bluff with a 50- to 60-foot drop on three sides. The village site appears to have been occupied to some degree until the early eighteenth century, probably into the 1720s. Mohegan Entailed or Sequestered Lands, sometimes referred to as Mohegan Fields, a *de facto* reservation, was established by Uncas and the English by 1671. Historic documents make specific reference to “planting fields” that would have supported Mohegan villages.

Of the said Lands comprized in the said Deeds of the 9th of May 1671. And 6th of March 1683 called the Entailed or Sequestred Lands which was chiefly planting ground and lay between the sd. Towns of New London and Norwich and was Eight Miles and upwards in length and four Miles upwards in breadth the Westerly End whereof lay upon the Connecticut River. (Public Record Office: 30)

In the first half of the twentieth century, collectors pilfered many artifacts from Shantok.

The first systematic excavations at Shantok were conducted by Salwen between 1962 and 1970 (Williams 1972). As a result, we know that Shantok was surrounded by a rectangular fortification with bastions. Subsequent work sponsored by the Mohegan Tribe between 2000 and 2005 has verified Salwen’s findings and identified numerous features from which flotation samples were collected. These are now in the preliminary stages of processing and analysis. Apart from wood charcoal, macrobotanical remains from Shantok are skewed heavily toward agricultural specimens. Corn and beans represent 98% of the cumulative identified botanical remains if wood charcoal is excluded. This result is not surprising considering the relative abundance of agricultural implements at

Table 14-1. Macrobotanical remain counts from Shantok Village.

Common Name/ Scientific Name	1962–70	2000	2003	2004	2005	Total
Corn Kernel/ <i>Zea mays</i> ssp. <i>mays</i>	139	212	156	34	40	581
Corn Cob/ <i>Zea mays</i> ssp. <i>mays</i>	0	1	0	0	0	1
Common Bean/ <i>Phaseolis vulgaris</i>	7	19	5	1	5	37
Peach/ <i>Prunus persica</i>	1	1	0	0	0	2
Oak/ <i>Quercus</i> spp.	1	0	0	0	0	1
Hickory/ <i>Carya</i> spp.	1	0	0	1	0	2
Unidentified Nutshell	1	2	0	0	0	3
Unidentified Seed	2	3	0	0	0	5
Unidentified Wood Charcoal	3,522	15,752	4,802	6,970	4,691	35,737
Total	3,674	17,990	6,966	9,010	6,741	36,369

Table 14-2. Identified terrestrial mammal remain bone counts from Shantok Village.

Common Name/ Scientific Name	1962–70	2000	2003	2004	2005	Total
White-Tailed Deer/ <i>Odocoileus virginianus</i>	3,964	77	8	10	32	4,091
Striped Skunk/ <i>Mephitis mephitis</i>	50	0	0	0	0	50
Eastern Grey Squirrel/ <i>Sciurus carolinensis</i>	25	0	0	0	0	25
Raccoon/ <i>Procyon lotor</i>	24	0	0	0	1	25
Rabbit/ <i>Sylvilagus</i> spp.	21	0	0	0	0	21
American Black Bear/ <i>Ursus americanus</i>	15	0	0	0	0	15
Grey Fox/ <i>Urocyon cinereoargenteus</i>	4	0	0	0	0	4
Mouse/ <i>Mus</i> pp.	1	0	0	0	0	1
Marmot/ <i>Marmota monax</i>	4	0	0	0	0	4
Bobcat/ <i>Lynx rufus</i>	4	0	0	0	0	4
Total Wild Mammals Specimens	4,112	77	8	10	33	4,240
Canine/ <i>Canis lupus</i>	9	0	0	0	0	9
Pig/ <i>Sus domesticus</i>	2	0	0	0	0	2
Sheep/ <i>Ovis aries</i> or Goat/ <i>Capra aegagrus hircus</i>	10	0	0	0	0	10
Horse/ <i>Equus caballus</i>	5	0	0	0	0	5
Cow/ <i>Bos primigenius taurus</i>	2	0	0	0	0	2
Total Domesticated	19	0	0	0	0	28
Total Terrestrial Mammals	8,271	77	8	10	33	4,286

Table 14-3. Avian and reptile remain bone counts from Shantok Village.

Common Name/ Scientific Name	1962–70	2000	2003	2004	2005	Total
Unidentified Avian Remains	973	57	131	26	9	1,196
Turkey/ <i>Meleagris gallopavo</i>	68	0	0	1	2	71
Turtle/ Order <i>Testudines</i>	53	0	0	2	5	60
Total Avian and Reptile Remains	1,094	57	131	29	16	1,327

Shantok, such as hoes, and is also consistent with Mohegan oral tradition regarding the central importance of maize agriculture.

As we are only in the early phases of our paleoethnobotanical analysis, these findings should be considered preliminary (Table 14-1). Over 300 soil samples have been processed using a Flote-Tech Model A, resulting in approximately 900 fractions. One hundred and thirty fractions have been sorted in the laboratory. Identifications of the botanical materials have yet to begin in earnest. However, some interesting patterns can already be seen in the preliminary data (Table 14-1) that

we are confident will help us better understand the seventeenth century subsistence system of the Mohegan people (see discussion below).

In addition to evidence of maize agriculture, Shantok has abundant evidence for the exploitation of animal resources (Tables 14-2 and 14-3). Again, this analysis is in its early stages. However, 38,925 faunal remains (excluding marine shell) have already been cataloged. Of these, 17,862 specimens have been identified to some degree. Of the identified specimens, about 24% were terrestrial mammal, 69% fish, 7% avian, 0.3% reptile. Perhaps the most interesting finding is the very small proportion of

Table 14-4. Fish remain bone counts from Shantok Village.

Common Name/ Scientific Name	1962–70	2000	2003	2004	2005	Total
Striped Bass/ <i>Morone saxatilis</i>	36	0	0	0	0	36
Sturgeon/ <i>Acipenser oxyrinchus</i>	47	0	0	6	0	53
Tautog/ <i>Tautoga onitis</i>	14	0	0	1	1	16
Shark/ Suborder <i>Selachimorpha</i>	4	0	0	0	0	4
Unidentified Fish Remains	4,081	4,770	2,065	1,154	107	12,177
Total Fish Remains	4,182	4,770	2,065	1,161	108	12,286

Table 14-5: Marine shell fragment counts from Shantok Village.

Common Name/ Scientific Name	1962–70	2000	2003	2004	2005	Total
Common Oyster/ <i>Ostrea virginica</i>	60	29,932	50,725	90,539	3,920	175,176
Soft Shell Clam/ <i>Mya arenaria</i>	37	8,440	25,716	9,853	1,139	45,185
Quahog/ <i>Venus mercenaria</i>	445	113	108	316	121	1,103
Whelk/ <i>Busycon</i> spp.	1,156	90	122	244	121	1,733
Mussel/ <i>Mytilus</i> spp.	75	396	441	105	122	1,139
Bay Scallop/ <i>Pecten irradians</i>	11	0	1	51	5	68
Periwinkle <i>Littorina littorea</i>	28	9	12	15	3	67
Unidentified Shell	84	620	111,637	119,833	427	232,601
Total Marine Shell	1,896	39,600	188,564	220,956	5,858	457,072

domesticated species (horse, cow, pig, and sheep/goat) represented in the sample comprising less than 0.6% (see Table 14-4). These data indicate the broad and almost exclusive exploitation of wild animal resources by the inhabitants of Shantok with an emphasis on marine and estuary resources. Domesticated animals were, at best, a very small component of the subsistence system.

Another important contribution to subsistence came from shellfish, as marine shell comprised a prominent part of the archaeological assemblage. Excluding Salwen's collection, which we consider unrepresentative, a total of 222,659 marine shell specimens were identified (Table 14-5). Of these, oyster comprised about 79%, soft-shell clam 20%, mussel 0.5%, quahog clam 0.3%, whelk 0.3%, and scallop at less than 0.1%. The abundance of oyster is not surprising considering the proximity of the oyster beds in the Thames River just below the site. Harvesting soft shell clam, quahog clam, and whelk (which require more saline conditions than that found at the Mohegan Reservation) would have necessitated travel south toward the Fisher's Island Sound, about eight miles down the Thames River from Shantok. However, wampum fabrication and shell temper production for Shantokware manufacturing may be partially responsible for the relative paucity of quahog and whelk shells at Shantok.

Seventeenth-century Mohegans at Shantok appear to have been fully committed to the cultivation of corn, beans, and presumably squash and tobacco. Josselyn (1988:93) describes several ways in which corn was prepared, including: (1) "Indian corn and Kidney beans they

boil;" (2) "parcht or roasted in the ear against the fire"; and (3) "They beat their corn into powder and put it up into bags." Both archaeological and documentary descriptions indicate that broad-based hunting and gathering were maintained as a supplement to increased reliance upon agricultural production in a complex subsistence system that exhibited some remarkable continuity, most notably the exploitation of marine and estuary resources as well as terrestrial mammals. As we would expect from Bradford's (1987) early seventeenth-century account, iron hoes have been discovered at Shantok. However, even more numerous stone hoes have been discovered in the village itself and scattered in the surrounding arable land. In addition, Lorraine Williams identified 15 storage features at Shantok which she asserted were for the storage of cultigens and indicate a fall and early winter seasonality (Williams 1972:77–78).

Paradoxically, there have been very few carbonized nut shell remains identified at Shantok to date. In comparison, the Burnham-Shepard, Butternut Knoll, and Kashita sites, all Late Woodland sites in South Windsor, Connecticut, yielded a total of 3,069 hickory nut, 624 butternut, and 17 hazelnut specimens (Bendremer 1993). Hickory and butternut were also discovered at the contemporaneous Morgan site in Rocky Hill as well as hickory and acorn at the coastal Mago Point site in Niantic, Connecticut (Lavin 1988). It is also possible that with further processing, our soil samples will reveal the missing nut shells. However, it may be that the lack of nuts is an indication that Shantok, despite the presence of some storage features, was not generally occupied long after

the harvest. Perhaps the inhabitants removed to sheltered valleys during the cold months taking most of their cultigens with them and only returning to Shantok for the anadromous fish runs in the spring. Alternatively, it seems possible that community movement outside of the fortified village could have been rendered impossible during times of hostilities for security reasons or because even seasonal relocation would have resulted in lost trading opportunities. With additional analysis, we hope to shed further light on these issues.

Mohegan Subsistence in the Eighteenth and Nineteenth Centuries

By the eighteenth century, the reservation had been well established. It is clear that there were decreases in population, changes in some aspects of the subsistence system and disruptions to social institutions. For example, by 1719 the Connecticut General Assembly had begun to appoint guardians or overseers to the tribe who handled most of their financial affairs. Furthermore, the Sachemship as an institution recognized by the colony expired on the death of the last Sachem, Isaiah Uncas, in 1770, in favor of a tribal council (Peyer 1997: 82). In addition, by the time of the American Revolution, the Brotherton Movement resulted in an exodus of Mohegans bound for Oneida country in New York State. Even considering these disruptions to Mohegan institutions, however, there is no reason to believe that maize agriculture becomes any less important to the Mohegan people.

Five late-eighteenth and early nineteenth-century Mohegan homestead sites have been excavated on what was the original Mohegan Reservation. Besides tentatively identified wood charcoal, there have been very few other macrobotanical specimens identified as yet and only one corn kernel (Table 14-6). Although the rarity of identifiable archaeobotanical corn may speak against the significance of agriculture, there are historic documents that mention substantial planting fields at Poomechaugge (New London County Court Records 1739) and Massapeag (Hallam 1703). Furthermore, Kevin McBride has identified archaeological corn at sites on the Mashantucket

Pequot Reservation, only about 12 miles away from Mohegan (McBride 2006). It seems possible that with the construction of fireplaces, replacing fire pits, as is the case with these sites, fewer starchy botanical remains became carbonized or are confined to as yet unexcavated portions of these sites.

McBride has also discovered a variety of soft tissue plant remains which speaks to the importance of tubers in the southern New England Native diet (McBride 2006) and it is possible that some of these carbonized soft tissue plants may be identified during the upcoming botanical analysis. As at Shantok, there are very few identified carbonized nutshells so common at pre-European Contact sites.

The most notable change in the subsistence system is the adoption of animal husbandry by Mohegans. Whereas the percentage of identified domesticated animal remains at Shantok was less than 1%, domesticated animal remains at five late-eighteenth and early nineteenth-century households were a minimum of 50% of the terrestrial faunal assemblage, even if we assume all unidentified avian specimens were wild (Table 14-7). This represents a significant shift in the subsistence system likely in direct response to restrictions on hunter's movements and the probable overhunting of local animal populations.

The exploitation of shellfish continues into the eighteenth and nineteenth centuries with increased reliance on locally available oyster shell (Table 14-8). Oyster constitutes over 99% of the identified shell specimens. Again this suggests some limits on the mobility of Mohegan people, in this case the ability to access coastal waters. A 1736 description of Mohegan Sequestered Lands includes the following: "And I find that the whole of the above Tract of Land is good for Planting, Mowing, and Pasturing: and contains between four and five thousand Acres as appeared above, is well water'd, accommodated with timber and lyes upon a fair River called and known by the name of New London River abounding with Clams, Oysters and Divers other Sorts of Fish easily to be taken by the Indians, and contributing much to their Subsistence" (Avery 1736).

Table 14-6. Macrobotanical remain counts identified at five late eighteenth to early nineteenth century Mohegan sites.

Common Name/ Scientific Name	Uncas Cabin	Dolbeare 1	Fowler	Trading Cove Ravine	Miller-Fielding	Total
Corn/ <i>Zea mays</i> ssp. <i>mays</i>	0	0	0	1	0	1
Bean/ <i>Phaseolis vulgaris</i>	0	0	0	0	0	0
Possible Apple	0	0	0	3	0	3
Oak/ <i>Quercus</i> spp.	0	0	0	0	0	0
Hickory/ <i>Carya</i> spp.	0	0	1	0	0	1
Unidentified Nutshell	0	0	0	21	0	22
Unidentified Seed	1	0	0	2	0	3
Probable Wood Charcoal	1,801	360	656	9,287	269	12,373
Total	1,802	360	657	9,314	269	12,403

Table 14-7. Faunal remain bone counts identified at five eighteenth to early nineteenth century Mohegan sites.

Common Name/ Scientific Name	Uncas Cabin	Dolbeare 1	Fowler	Trading Cove Ravine	Miller-Fielding	Total
Unidentified Rodent	3	0	1	1	1	4
Unidentified Avian	11	0	0	5	0	14
Unidentified Fish (plus scales)	6	0	0	83	0	89
Total Wild Species	20	0	1	89	1	107
Pig/ <i>Sus domesticus</i>	50	4	6	4	0	64
Sheep/ <i>Ovis aries</i> or Goat/ <i>Capra aegagrus hircus</i>	2	0	0	0	0	2
Cow/ <i>Bos primigenius taurus</i>	5	0	3	3	0	11
Chicken/ <i>Gallus gallus</i>	1	0	0	0	0	1
Total Domesticated Species	58	4	9	7	0	78
Total Identified Faunal Remains	78	4	10	96	1	189

Table 14-8: Identified marine shell remain fragment counts from five late eighteenth to early nineteenth century Mohegan sites.

Common Name/ Scientific Name	Uncas Cabin	Dolbeare 1	Fowler	Trading Cove Ravine	Miller-Fielding	Total
Common Oyster/ <i>Ostrea virginica</i>	3,824	291	6,093	41,628	381	52,217
Soft Shell Clam/ <i>Mya arenaria</i>	0	0	0	4	1	5
Quahog/ <i>Venus mercenaria</i>	54	247	9	1	1	312
Whelk/ <i>Busycon</i> spp.	0	0	0	2	0	2
Mussel/ <i>Mytilus</i> spp.	0	0	0	2	0	2
Bay Scallop/ <i>Pecten irradians</i>	0	0	0	2	0	2
Periwinkle <i>Littorina littorea</i>	2	1	0	11	1	15
Marine Shell Total	3,880	539	6,102	41,650	384	52,555

Continuity and Change in the Nineteenth and Twentieth Centuries

Although we have not had the opportunity to excavate any late nineteenth or twentieth century Mohegan sites, there is anecdotal archaeological and documentary evidence that suggests that maize agriculture was still very significant, especially in a symbolic sense. For example, in 1842 a description of a festival at the Mohegan Church with all the trappings of the later Wigwam Festival included: "Here a huge wooden bowl of savory, smoking, *succotash*, stood with its wooden ladle, invitingly ready. There an Indian woman was instructing novices in the art of making *yohcake*—a preparation of pounded parched corn with rich cream, while in another place wild strawberries were offered in Indian baskets" (Daily Courier 1842). Yokeag (also known as nocake in Massachusetts) was described in 1634 by Wood (1977:87), "the best of their victuals for their journey is nocake (as they call it), which is nothing but Indian corn parched in hot ashes." In addition, corn fields of indeterminate age were still visible in the early twentieth century at Mohegan. Since they were observed in the 1920's, it is certainly possible that they date from sometime in the nineteenth century.

The corn hills observed during a few days visit to Mohegan last August are in two localities.

One of them is in an 8 to 10 acre pasture on high ground, a few minutes walk southeast of the Indian meetinghouse . . . It is of no little significance that there is an unbroken tradition at Mohegan regarding these corn hills. Anyone asked will point them out as such. (Hallowell 1921)

However, by the late nineteenth century, though maize agriculture is still practiced, wage labor appears to have become more important. In 1870, an overseer wrote, "Some do a little farming, but it is in a small way. They prefer to get their living fishing or laboring for others." (Talcott 1870) It should be noted that it was in the interest of Europeans, including their overseers, to underestimate the importance of Mohegan land use and numbers as the reservation was increasingly eroded over time with the remainder finally allotted to the tribal members in fee simple between 1869 and 1874.

It is interesting to note that, even while maize agricultural at Mohegan might have been declining, its importance ideologically was undiminished and evolving. For example, the Mohegan Green Corn Dance, the traditional celebration of the corn harvest, had evolved by 1848 into the Wigwam Festival held annually at the Mohegan Church. Speck (1928:222) mentions mortars and pestles,

whose main function was grinding of corn, as a prominent component of Mohegan material culture well into the early twentieth century. Speck (1928:255) recalls:

For some days before the festival, several men are kept busy pounding up quantities of corn for yókeg, which the women and children have roasted. Several large mortars are kept exclusively for this purpose, and are common property of the tribe. These are kept in the custody of the Tantaquidgeon family . . . The fact that it takes place at the height of the corn season and that corn products, particularly yókeg and su'ctac (parched corn powder and corn and bean soup), play such an important part in it, are clear indications of the early nature of the festival.

Not coincidentally, several 8-rowed northeastern flint corn cobs were discovered in the crawlspace beneath the Mohegan Church along with fragments of bulrush matting. In the 1930s, yokeag and succotash were still being served at Wigwam Festivals and enjoyed in Mohegan households, "Mrs. Gray explained how yokeag is made, adding that she still makes it and uses it for breakfast cereal or for sprinkling on ice cream" (Colby 1934).

It is important to note that without the benefit of the documentary record and Mohegan oral tradition, it would be very easy to underestimate the significance of corn in the eighteenth through twentieth centuries. Paleoethnobotanists must be aware that it is possible that the importance of a food resource may not always be reflected in its archaeological prevalence alone (see Hart, this volume).

Even today, corn figures prominently in tribal members' lives as exemplified by their communal involvement with a Three Sisters Garden and the fact that a number of tribal families are still proud to possess cherished mortars and pestles that have been handed down from generation to generation. Taken together, we can appreciate the symbolic significance of corn and maize agriculture in the Mohegan community and the remarkable continuity associated with corn from ancient times to the present.

"We were taught to plant 5 corn kernels in each mound. One for each of the four directions and one for the crow who brought us corn from the southwest . . ."

—Mohegan Tribal Member 2006

"It's important for our tribe to perpetuate a crop year after year to pass on to future generations."

—Chairman, Mohegan Council of Elders 2006

CONCLUSION

Mohegan subsistence systems have undergone a number of shifts from pre-European Contact through recent times. During the Late Woodland, southeastern coastal Connecticut maize agriculture was at best a supplement to broad-based hunting and gathering adapted to local variations in resource availability.

With the arrival of Europeans, corn, beans, and squash became more important in support of larger, more sedentary fortified villages. These villages were the result of population loss, economic interdependence with the colonists, increased territoriality, warfare, and disruption of traditional lifeways. Although the intensification of warfare certainly affected men's allocation of time, their subsistence activities seem to have remained little changed based upon the wide variety of animal resources identified at Shantok. Women, however, appear to have shifted their subsistence activities toward maize agriculture and away from the procurement of wild plant foods. Fishing and shellfishing, often less appreciated, are also central components of the subsistence system.

By the eighteenth century, Mohegan subsistence undergoes another shift. Instead of relying primarily on wild animal resources, domestic animals predominated. It is assumed that maize agriculture continues to be an important part of the subsistence system, although little direct evidence has been discovered at Mohegan.

By the nineteenth century, corn takes on a more symbolic or ideological importance. Wage labor, cottage industries, soldering, seafaring/whaling, and other income generating activities became more prevalent during this period and contributed substantially toward subsistence. Also, beginning in the eighteenth century and continuing through most of the nineteenth century, tribal income was generated from leases and sales of tribal lands. Throughout this period, the ideological importance of corn increased while fewer and fewer Mohegans lived on a diminishing reservation land base. Although it is clear that flint corn was still cultivated, or at least available, throughout the nineteenth century and even through most of the twentieth century, it is critical for paleoethnobotanists to acknowledge that the importance of maize cannot always be inferred solely on its prevalence in archaeological sites. Corn dishes prominently featured at Mohegan cultural events and Wigwam Festivals through the nineteenth and twentieth centuries speak to its centrality in Mohegan identity and consciousness despite its low visibility otherwise. And corn continues to hold great significance for Mohegan people today, as exemplified by the recent revival of traditional maize agriculture and a number of traditional corn-based dishes and crafts.

Additional archaeological work, processing of all

remaining flotation samples, and the completion of botanical and faunal analyses will provide much needed data to better understand the shifts in subsistence systems through the colonial period. We hope this information will better illuminate the evolution of the complex subsistence systems at Mohegan and allow the Mohegan Tribe a better vantage to view the world of their ancestors.

ENDNOTE

¹. To provide the most precise cultural context and in keeping with both the historic and contemporary terminology of the Mohegan community, the term “corn” is used in this chapter while referring to *Zea mays* ssp. *mays* and associated material culture. However, the term “maize” is used when referring to more abstract concepts such as Native agricultural systems and related components of the Mohegan social system.

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CHAPTER 15

EXPLORING NEW DIMENSIONS IN THE STUDY OF ARCHAEOLOGICAL PLANTS

by Jack Rossen

The first *Current Northeast Paleoethnobotany* volume was published in 1999, and this is a good opportunity to assess where archaeobotany (or paleoethnobotany, if you prefer) stands as a sub-discipline of archaeology. That volume represented the decentralization of archaeobotany as it moved out of its traditional regional power base of the Midwest. When I worked in New England in the early 1990s, there was a prevailing belief among archaeologists that archaeobotany was not a useful or cost-effective specialization in the Northeast, either because of the acidic soils or the poor preservation of plant remains.

I reviewed the CNP volume in *Northeast Anthropology* and gave it a mixed report card (Rossen 1999). The strengths were the clear definition of key research issues, which are further discussed in this volume: the circumstances and timing of cultivation in the Northeast, the nature of regional plant use variability, the debates on plant use models and the applicability of midwestern seed plant horticultural concepts, and the relative importance of environment and climate (long-term, local, and microenvironmental) to plant use systems and subsistence change. On the negative side, I was disheartened by some of the spotty background research, particularly the lack of attention to more recent archaeobotanical finds, the insistent emphasis on AMS dating as the panacea for our research, and the all-too-common absence of crucial information like soil sample volume (liters) and densities that allow comparison and evaluation and ultimately make archaeobotany scientific. The volume was thus representative of archaeobotany itself. The discipline continues to experience growing pains and pleasures, and specialists are faced with increased service demand and a rapidly expanding database. We have been trying with only mixed success to achieve scholarship, judicious use of new technologies such as AMS dating, scientific reporting standards, and theoretical sophistication.

This is an unsettled time, a crossroads, for archaeobotany, but also is a time for tremendous opportunity. Since the 1970s, the pioneers of the modern sub-discipline have concentrated on methodology, and we are getting closer to establishing standards for handling, statistically manipulating, and reporting plant remains. We have largely confined ourselves to reconstructing plant use inventories and systems, and understanding the development, adoption, and relative importance (or unimportance) of cultivated plants. Nearly three decades ago, Richard Ford wrote that “much of the potential of archaeological plant materials for anthropological interpretation remains to be implemented” (Ford 1979:281). He blamed the difficulty in maximizing the information from ancient plants on the scarcity of well-trained specialists and “the different perspectives botanists and archaeologists use to interpret archaeobotanical data.” In an attempt to unify and focus archaeobotany, Ford defined five basic categories of research:

1. Uses of plants
2. Origin of agriculture
3. Environmental reconstruction
4. Human adaptations
5. Prehistoric ideology

With Ford’s definitions, the basic boundaries of modern archaeobotany were established. This framework refined the efforts of archaeobotanists and helped lead to a detailed understanding of the worldwide diversity and complexities of the hunter-gatherer transition to agriculture (see Harris and Hillman 1989). It was a foundational statement that was significant at the time. I would argue, however, that it also constrained archaeobotanists from developing a true theoretical sophistication for their sub-discipline. By working within Ford’s guidelines, archaeobotanists have not often pushed to learn the roles of plants in a range of diachronic and synchronic issues

important to archaeology. Instead, archaeobotanists have left the issues of cultural evolution, chronological thresholds, identity, status, sociocultural boundaries, ideology, political aggression, resistance, and syncretism to colleagues who work with architecture, settlement patterns, ceramics, and lithics.

There have been important exceptions, of course, which stand out in their innovative use of plant remains. For example, Hastorf (1993) treated plant remains and the agricultural systems they represent as a social system and thus as a mirror of social interaction and political organization. By correlating plant use change with non-agricultural data on social, political, and economic change, she was able to understand the multiple causes of the onset of political inequality in the Jauja region prior to the Inka conquest. By placing agricultural production at the center of the dynamics of society, this case study escaped the clichés that have hampered archaeobotany, such as the simplistic notions that ecological diversity promotes the development of agriculture and that population pressure is at the root of agricultural intensification and political centralization. Instead, Hastorf constructed a model of power based on the notion that people act on their desires and use labor to transform the world. She also partially based her model on the importance of high-status plants like maize (particularly for the manufacture of religiously important chicha beer), which was increasingly difficult to obtain as populations moved to higher altitudes. By correlating a high-status plant with other status materials such as textiles and certain ceramics, Hastorf was able to see maize as an impetus for social control and change, and agriculture in general as a “fulcrum for those changes” (Hastorf 1993:226). By placing plant remains at the center instead of the periphery of her cultural analysis of power in pre-Inkan Peru, a complex, nuanced, and convincing model of cultural and political development was projected that avoided a single cause or prime mover explanation. Although the Northeast never prehistorically achieved state levels of power comparable to the Andes, there may be plant use changes here to also indicate reorganization of power, such as in the consolidation and formation of the Iroquois (Haudenosaunee) groups and their confederacy.

A second example comes from an unlikely region, the Indus Valley of Pakistan, where archaeobotanists have brought a fresh perspective to the analysis of plant remains. Through an extensive flotation collection effort, Weber (2003) defined a pattern at Harappa where the early domination of barley in the farming system was supplanted by wheat as the primary food plant and then was overtaken again by barley late in the sequence. During the same sequence, continuing efforts to diversify agriculture were made by adding new cultivated plants without dropping any from the inventory. Fuller (2003)

viewed these plants as new status foods and markers of ethnic identities as the Harappans became more integrated with people along its periphery. In this scholarship, crop choices are viewed not so much as functional food supply issues but as indicators of the increasing social role of food preparation and consumption, along with ethnic interactions. Plants are thus viewed as regional integrators, particularly as certain plant choices advanced the relationships between agriculturalists and pastoralists, because certain crop by-products made good animal fodder (Reedy 2003). Just as in the Peru case study, the detailed archaeobotany that is emerging from the Indus Valley is at the forefront of more complex and multi-dimensional models of the rise and disintegration of societal complexity.

Archaeobotany now stands at the threshold of true theoretical sophistication. I would first like to offer some examples of the possibilities, within research issues like cultural evolution and chronological thresholds, status, ideology, and politics. The examples come from both pre-historic and historical archaeology, and from within and beyond the Northeast. The relevance of these examples to this region may be up to our collective creativity and scholarship. I will also argue that a new theoretical archaeobotany is central to the emerging paradigm of indigenous archaeology, that is, an archaeology that is collaborative with and a positive force for Native peoples. Then I can assess how we are doing on our journey in northeastern North America based on the varied contributions to this volume.

CULTURAL EVOLUTION AND CHRONOLOGICAL THRESHOLDS

There is a trend in archaeology to smooth out cultural transitions and see them as having been more gradual than was previously believed. The present debate over the development and nature of Owasco in New York is a great example. In the Owasco case, it seems that ceramics, lithics, architecture, and plant remains may have appeared in New York at different times, muddying a unified concept of the Owasco (Proto-Haudenosaunee) Culture (Hart and Brumbach 2003). Yet in the Ohio Valley, plant remains can sharply delineate culture change in a way that architecture, settlement patterns, ceramics, and lithics cannot. In northern and central Kentucky, the transition from Woodland plant economies with lots of nuts, native cultigens, and a dabble of maize as late as ca. A.D. 980 rapidly became a maize (and maybe beans) agricultural economy of a heterarchical cultural group we call Fort Ancient during the first decades of the eleventh century A.D. This transformation sometimes appears gradual, for instance in terms of ceramics and settlement

patterns, but in terms of plant subsistence the shift was sudden (Turnbow and Sharp 1988). We can view sites barely a few decades apart to document the sudden florescence of a true maize agricultural system that also includes a de-emphasis of time-honored plant resources like nuts and most native cultigens, with the notable exception of cultivated chenopod (*Chenopodium berlandieri*) (Pollack and Henderson 2000; Railey 1996; Rossen 1992; Sharp 1996). Once established, and despite some minor regional variation, the Fort Ancient plant use pattern and its clear distinctions from more westerly and southerly Mississippian patterns of heavy nut and native cultigen use beneath the maize umbrella is stable and predictable (Rossen and Edging 1987).

The issue of when beans arrived in the eastern U.S. and Northeast (Hart et al. 2002) is currently hinging on two sites. First is the reanalysis of materials from the Muir site, an eleventh century Fort Ancient village in central Kentucky. The second is another Kentucky site, Shippingport Island, with eleventh- and thirteenth-century houses.

After ca. A.D. 1400, all bets are off. In western Kentucky, the Mississippian towns were abandoned or in decline, and populations may have been dispersing (Williams 1990). In central and eastern Kentucky, the Madisonville Horizon emerged, including the formation of large linear villages, especially along the Ohio River, the appearance of Mississippian design elements on ceramics, and possibly a population influx from the west (Henderson 1992). At the mouth of the Wabash River, at its confluence with the Ohio in western Kentucky, the Caborn-Welborn Culture emerged from the ashes of the Mississippian chiefdoms (Pollack 2004). Plant remains from Caborn-Welborn sites include *Phaseolus* beans, apparently making their first appearance in the region, along with a mixture of 8- and 12-row maize types, suggesting a new diffusion of cultural influences in the absence of centralized chiefly power (Rossen 1994). The strict dichotomy of the east-west model thus disappeared at the cultural threshold of ca. A.D. 1400. So in the middle Ohio Valley, there are two sweeping thresholds of culture change, at ca. A.D. 1000 and 1400, and these thresholds are more sharply defined by plant remains than by ceramics, lithics, or settlement patterns, suggesting that plant use decisions are at the forefront of culture change.

The sociocultural boundary between western Mississippian and Fort Ancient groups from ca. A.D. 1000 to 1400 seemed stark and impermeable. However, recent analysis of two sites, Eva Bandman and Shippingport Island near Louisville, the falls of the Ohio, or a boundary spot between Mississippian and Fort Ancient (including Indiana's nearby Oliver Phase), indicate a more permeable boundary. Elements of both Fort Ancient and Mississippian plant use systems have been isolated.

Varieties of maize associated with both cultures (Fort Ancient "Eastern Eight" and Mississippian "Midwestern Twelve") are present, intermingled within individual flotation samples. The *Phaseolus* beans and the sole presence of chenopod (of the native cultigens) in this collection match the Fort Ancient and Oliver Phase pattern. The absence of other native cultigens like maygrass (*Phalaris caroliniana*) and marshelder (*Iva annua*), all heavily used and hybridized by western Kentucky Mississippians, is also significant. Furthermore, wild plants like sumac, blackberry, grape, and pawpaw are associated with the Fort Ancient/Oliver, who more strongly maintained a wild plant collecting component that emphasized fleshy fruits. Nutshell densities are also more like Fort Ancient/Oliver than Mississippian patterns. But the presence of Mississippian "Midwestern twelve" maize, pecan and wild bean are markers of Mississippian plant use that are absent from Fort Ancient and Oliver Phase collections. Overall, the Eva Bandman collection displays the mixed indicators of a permeable boundary, but with a stronger influence from the Fort Ancient lifeway in terms of plant use (Rossen 2004; also see Bush 2004 for a similar plant use boundary case study of the Oliver Phase). It is interesting to note that ceramics from the site also display both Mississippian and Fort Ancient traits, but appear overall to be much more Mississippian in character (Henderson 2004, 2005; Henderson and Pollock 2004). The upshot of this is that the plant remains give us a complex nuanced look at a sociocultural boundary, including its cultural permeability, which cannot be achieved by ceramic and lithic analysis alone.

PLANTS AND STATUS

Plants have status, and archaeobotanists have barely begun to explore this issue. Let's consider briefly the lowly *Phaseolus* bean. Beans entered Kentucky ca. A.D. 1000 to 1200 (and probably later in New York and New England; see Hart et al. 2002) and became important mostly among tribal populations like the Fort Ancient, who lived on the peripheries of the more populated and centralized Mississippian chiefdoms. Despite its dietary importance, the plant had not undergone the ritualization process that maize had. In terms of the archaeological record this means several centuries of low-level archaeological visibility that suggests only minor use. Maize appears as only 1 or 2% of archaeobotanical assemblages throughout the eastern woodlands for at least 800 years (Chapman and Crites 1987; Crites 1978), but beans appear to have been used in abundance almost immediately upon their arrival. It thus seems that beans were relegated to low status in comparison with maize. Beans were later transferred to the earliest Euro-American home-

steads in Kentucky, who perhaps because of their desires to hold onto the Old World grains like wheat and barley that were poorly adapted to Kentucky's climate, maintained the plant's low status (Rossen 2003a, 2003b). Beans declined in use and are totally absent from high-status antebellum sites like Ashland, the estate of Henry Clay in Lexington, Kentucky (Scarry 1993). Beans were revived by the Civil War necessity of feeding enormous soldier populations, and their popularity was expressed exclusively by the lowest rank and file soldiers at sites like Camp Nelson, a Union Quartermaster Depot where high- and low-status areas were well-defined (Rossen 2003c). So not only do we have examples of plants having clearly defined high or low status, but these positions may be transferred from Native to Euro-American populations.

IDEOLOGY AND PLANTS

Ideology is embedded in plant use systems as well, and in the Northeast this might be operationalized in terms of where people accepted and rejected plant cultivation (Bendremer 1999; Chilton 1999). Are these differences merely the product of the environmental limits of agriculture? Maybe, but there are examples where people went to enormous effort to cultivate plants far beyond its normal margins (Bendremer and Dewar 1994). For example, high altitude agricultural sites of the Formative period (ca. A.D. 1–600) in northwestern Argentina containing stunted maize, beans, and chenopod that were (and are still to a limited extent) grown at 10,000 ft seem to be a triumph of ideology over practicality (Rossen et al. 1998, 1999).

In final analysis the ancient Argentine system was extensive in the sense that large scale terracing and walling produced only limited strip areas near walls and terraces where maize and beans could be grown. These fields were strategically placed in microenvironments where sunrise to sunset exposure was maximized. This research orientation helps us understand that the vast size of agricultural fields, terraces, and reservoirs in the region is deceptive: only a fraction of the modified landscape was truly productive. We can begin to speculate about the tensions between practical agriculture and ideology, including ritual systems that require a larger food base and the social costs of producing that food. The system appears to have collapsed through time and the area was depopulated as a jaguar cult that bound people together faded (for an overview, see Gero and Scattolin 2002).

PLANTS AND POLITICS

How do plants help us get at political issues? The appearance of a plant far from its domestication center may be a

social or cultural act, but it is also a political one. Archaeobotanists have often dealt with plant diffusion, but of course diffusion is out of style in archaeology. Plants, however, do not have the ambiguity of ceramic and lithic styles. When we deal with plant diffusion, we are too often treating the plant as if it flew through the air without social or cultural mechanisms. The arrival of maize and beans in the Northeast has often been discussed without reference to family or cultural-level exchanges that occurred. There is a parallel in Chile where quinoa, a high altitude pseudo-cereal native to the high Andes of Peru and Bolivia was found at the southernmost known Inka site of Cerro del Inga, 100 miles south of Santiago, Chile (Planella et al. 1993; Rossen 2005).

In addition to the archaeobotanical materials, we also learned that quinoa was still being grown in isolated areas near the site; that due to its the fragile seed, the secrecy of the modern quinoa system, and lack of markets or market value, these quinoa growers were probably survivals of Inka period agriculture. We have come to view quinoa as a military strategy to transform the landscape of southern Chile, making it distinctively Inka, in order to consolidate the conquered peoples of the region. Of course, Inka architecture has long been viewed in exactly this way. We have also come to view the indigenous plant cultivation system, including plants such as the oily seeded madi (*Madia chilensis*), as representing local cultural syncretism and even perhaps cultural resistance to Inka domination, just as the Mapuche cultivation of this plant today represents one form of resistance to Chilean national domination (Rossen 2005).

PLANTS AND INDIGENOUS ARCHAEOLOGY

All archaeologists must work hard to overcome the historical insensitivity of the profession toward Native people and strive to change the negative stereotype that Native people have of archaeologists (Anonymous 1986; Benedict 2004; Jemison 1997). Participants in the "indigenous archaeology" movement are working to reform archaeology by making it a positive force for Native people and formulating collaborative, power sharing projects (Kerber 2006; Smith and Wobst 2005; Swidler et al. 1997; Watkins 2000). In the Cayuga Lake area of central New York, the Cayuga have been erased from the history books. Archaeology has been a powerful tool to emphasize the importance of Cayuga history to local people. The archaeology also supports the rights and desires of the Cayuga people to once again know and live in their original homeland and gives a measure of legal protection to the ancient sites, where after all, the ancient spirits dwell (Rossen 2006, 2008).

Within the paradigm of indigenous archaeology, plants are indeed powerful. As we relocate sixteenth-century herb gardens and reconstruct plant use, Native herbalists see their work validated and begin to push for a return to the true Native diet. In a region where the incidence of diabetes related to the consumption of processed sugars and the environmental poisoning of Native land reserves is epidemic, the potential of archaeobotany to be a productive and positive force for Native people is unlimited. In December of 2005, a group of concerned citizens and anthropologists transferred 70 acres to the Cayuga people for use as community gardens and a center to further the goal of maintaining ancient crop varieties and improving the health, well-being, and cultural revitalization of the Cayuga people (Hansen and Rossen 2007).

How does archaeobotany specifically fit into this? One example is the Wells Barn site, which appears to have been part of the eighteenth-century Cayuga village of Chonodote, known to the British and Americans as Peachtown for its 1,500-tree peach orchard. This is the only major Cayuga village to be located near the lakeshore in an unusually warm microenvironment. The research preliminarily suggests that Chonodote was a specialized processing site where peaches could be effectively grown and where they were dried and packed for exchange. What do peaches represent? Since they are of European origin, the established orchard represents a period of relatively friendly interaction between European and Native groups. The exchange of a special agricultural product tells us something of the specialized nature of some Cayuga settlements and the economic and social integration of their nation. The presence of tools chipped from coal slag at the site hints at the disintegration of those networks as the Cayuga came under increasing Euro-American pressure. The destruction of the peach orchard during the Sullivan Campaign of 1779, ordered by George Washington during the American Revolution, represents the destruction of the homeland and the dispersal of the Cayuga people, events from which they are still trying to recover (Cook 2000). It is the Contact period history of a Native people as seen through the lens of a fruit tree.

Analysis is nearing completion of materials from the sixteenth-century Cayuga village, named Village X to protect its location. The site is more typical than Chonodote because of its location one mile from the lakeshore along some high cliffs. In our first field season, we puzzled over an unusually deep (1 meter) midden near the cliff edge, specifically why these materials had not been thrown over the precipice. We also found a great number of small ground stone pallets that are too small for grinding maize.

Wandering around Village X we found a trail into an adjacent gorge, which we believe is an ancient path, considering that the rest of the site is protected by cliffs and earthen embankments. The area below is covered each summer in herbs, including many rare and endangered species all considered to be important women's medicine by Native herbalists (Keemer and Williams 2003). The puzzle pieces are falling together. We know from Chonodote of the existence of at least some economic and occupational specialization at Cayuga villages. We also understand that the land directly beneath the midden at the cliff edge had some importance that prevented garbage from being deposited below. We are working on more analysis including starch grain and pollen extraction to further advance our ideas, but our working hypothesis is that some medicinal activities occurred at Village X, with the area below the site being at least an herb collecting area if not a garden, and the many small pallets representing the production of medicines.

There are many possible comments to make on archaeobotany as a hallmark of an "indigenous archaeology" or archaeology that is positive for Native people. First, it is hard to look at an archaeobotanist as a looter or treasure hunter. We are after seeds and bits of wood, and now residues, phytoliths, and starch grains, and can thus be set apart from "treasure hunting archaeologists" in the minds of Native people. The stories of plants resonate with our Native friends. At several Cayuga sites, we are recovering examples of plant varieties like 8-row maize that the Cayuga are struggling to protect and maintain in the post-modern world. Archaeobotanists are in a unique position to place plant use and plant stories at the center of history and learn details about people-plant relationships, particularly how plants were at the heart of the social relations of a bustling Native nation. We can produce a tangible link between historic Cayuga people and a Clan Mother returning to her homeland to plant the three sisters (maize, beans, squash).

Today the cultural revitalization of Native people throughout North America is connected to various land reclamation and farming projects (LaDuke 2005). Native people are looking back to traditional practices in food and medicine. Within archaeobotany, we have incredible opportunities to work on collaborative gardening and farming projects with Native people, and to make archaeology a positive force for Native people for the first time. Archaeobotanists have advantages over other archaeologists in developing new relationships with Native people. NAGPRA opened the door a crack, and plants are a major avenue for opening the new vistas of the coming revolution that can save archaeology from neo-colonialist oblivion.

HOW ARE WE DOING?

Based on the 13 chapters making up the heart of this volume, how are we doing in northeastern North America in developing a more theoretical archaeobotany? Not too badly. The nuts and bolts of archaeobotanical methods continue to develop, including new emphases on locally relevant aspects of starch grain analysis (Messner et al.), residue analysis through gas chromatography/mass spectrometry (Reber and Hart), and phytolith analysis (Serpa). These newer research avenues are exposing both the weaknesses and strengths of traditional macrobotanical analysis and are altering our basic views of individual plant histories and trajectories. The new technologies are essential for overcoming the vagaries of macrobotanical preservation and recovery and understanding aspects of food preparation, storage, and “transportable food” that are inaccessible to macrobotanical analysts.

It is now clear that maize has a long history of low-level use in the Northeast that supports the idea that even where it was utilized by mobile populations as a food supplement, there was a well-developed cultural choice involved (Chilton). Meanwhile, macrobotanical evidence is accumulating so that regions of northeastern North America like Nova Scotia may now be considered (Deal and Halwas), while other areas like Pennsylvania (McConaughy) and Maine (Asch Sidell) are accumulating large data bases that allow complex evolutionary and ecological modeling. We must always remember the value of comparison and contrast with other regions. For example, in the Nova Scotia case, the importance of wetlands plants like pondweeds and spike rushes is downplayed, despite the demonstrated significance of wetlands plants during the Archaic period from Kentucky to New England (Rossen 2000).

Several of these works are reminiscent of the tensions in scholarship between individual plant histories, broader plant use profiles, and environmental change through time. The “three sisters” (maize, beans, squash) have three distinctive plant histories that become more disparate with new research (Hart). The importance of these plant histories to the classic debate of Iroquois immigration versus in situ development is correctly asserted. Future research is particularly important on this issue because of the scarcity of flotation era (post-1980) work on Owasco sites in New York.

The Northeast increasingly appears to have been a place of longer, more gradual transitions than previously believed in regions ranging from New York and Pennsylvania to New England. The increasingly poorly defined thresholds of the Princess Point Complex in Ontario prehistory (Pihl et al.) and the Owasco Phase in New York (Hart), both spurred by archaeobotanical data, are excellent cases in point. These cases stand in stark con-

trast to the Ohio Valley, where the accumulation of archaeobotanical data appears to have sharpened thresholds of change. Why is it that botanical remains appear to indicate more rapid cultural transformations in some regions than traditional data sets like ceramics and lithics while smoothing out culture change in other regions? Whatever the reason, plant remains are an important independent force in defining culture change, both in terms of sudden thresholds and gradual transitions, and are not just a secondary, supporting data base.

In terms of indigenous archaeology and plants, we still have a ways to go. The implications of this research for living Native people are still often indirect. For example, one avenue of progress is our acceptance of Native cultural systems on their own terms instead of pushing them into preconceived anthropological categories such as the dichotomy of foraging and farming societies (Stein). Our new understanding of the concept of mobile farmers with fluid settlement patterns is a case in point (Chilton). This set of papers raises significant questions about our relations with Native people. What is implicit in a story of an archaeologist’s presentation to a Native group of elders that maize was not so important in their history (Largy and Morenson)? This anecdote stands out in my mind as both progress and problem. How important is it to show the ideological importance of small-scale maize production (Largy and Morenson), how the diminishing nineteenth-century importance of maize was unrelated to its continuing ideological importance, or the link between the loss of corn agriculture and the diminishing land base and dispersal of a Native population (Bendremer and Thomas)? What are the “morals” of the story when subsequent research tends to confirm a Native oral history? Are archaeobotanists here to conduct scholarship for big Science? Are we here to tell Native people their true history? Or should we be actively constructing a history in concert with Native people? Should we fear losing our objectivity as scientists when we work to make archaeobotany a constructive force for Native people? Why can’t we conduct solid scientific research and also be sensitive to Native people? Let’s further discuss the implications of our scholarship for federal recognition and repatriation (Chilton). When will it be academically acceptable to place these issues up front as one justification for scholarship instead of as an embedded aside?

CONCLUSION

First, it is clear that we have barely scratched the potential of information that ancient plants can tell us. Botanical remains hold secrets in cultural realms far beyond ancient food inventories and agriculture. I once thought we were moving toward the end of the developmental phase of

archaeobotany that focused on methodology, but technological breakthroughs have shown that methodology is a never-ending and significant concern. We are also moving gradually toward theoretical sophistication by getting plants to tell us about a wider variety of cultural configurations and processes. The original CNP Volume was a tentative step in that direction, and a follow-up volume (Hart and Rieth 2002) began to address Northeast culture change issues from the standpoint of plants. The present volume is a substantial step forward. Still, I think that archaeobotanists have been a conservative group within archaeology, somewhat unwilling to explore the full explanatory power of the sub-discipline. I am urging archaeobotanists to push the envelope, to take one step further, to make archaeobotany a focal point of culture theory (for understanding issues like change, boundaries, status, and political aggression and resistance) and a central place for the indigenous archaeology movement. In general, I urge archaeobotanists to stake a greater claim to their prominent theoretical and practical place in archaeology.

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CHAPTER 16

DOMESTICATED LANDSCAPES OF THE PREHISTORIC NORTHEAST

by John Edward Terrell

Peter Bellwood (2006:63), an English archaeologist living in Australia who has written much about the origins of agricultural societies, recently confessed that for him “big pictures are far more significant than minutiae, and archaeology for me is a useless discipline if it cannot illuminate large scale processes within human history.” He immediately qualified this provocative statement by adding that he knows most scholars see going after the big picture and poring over minutiae as compatible and entirely complementary ways of getting science done. Yet the passion in his declaration is obvious. Are minutiae as insignificant as he seems to be saying? Or can archaeologists be just as passionate about minutiae that, when viewed from a distance may possibly look irrelevant and immaterial, yet when seen close-up, may show that what appears to be, say, a genuine Rembrandt or Manet is only a colorful ink-jet reproduction, or worse, a contrived fake?

STATE OF THE ART

There is little doubt that Bellwood would label the chapters in this volume as detailed. I would add that some are beautifully so. These contributions are also obviously written with passion. In his own writings, Bellwood sometimes seems intent on convincing us that his particular perspective on domestication and the origins of agriculture is not only substantial but also substantially correct. These chapters, in contrast, are content instead with showing us the research promise of paleoethnobotany as a way of getting at what was happening in the past. By so doing, this collection offers a fascinating insider’s look at a part of the world that I had not realize I could care so much about as I now do, having read what these authors relate.

While this collection is meant as a survey of the progress in this research area made over the years between a

symposium on paleoethnobotany held at the New York State Museum in 1996 and the 2006 meetings of the Society for American Archaeology, John Hart’s introduction to this set of papers might also be seen as a S.W.O.T. analysis of the present state and future prospects of such research in the Northeast. In the world of business jargon, a S.W.O.T. analysis is something commonly done as part of corporate strategic planning in which the *Strengths, Weaknesses, Opportunities, and Threats* facing an organization are identified as a foundation for taking action and making realistic business projections. Paleoethnobotany may not be a business, but according to Hart, it is a growing enterprise. Without distorting Hart’s observations too much, I hope, here is a brief S.W.O.T. analysis extracted from what he writes.

Among the current strengths of this research enterprise may be listed the growing number of analytical techniques capable of exploring new, or at least vastly strengthened, lines of evidence documenting both how humans made use of plants in the past, and perhaps also how changes over time, or from one locale to another, in the substance and texture of human-plant interactions have influenced other aspects of human behavior and environmental adaptation. Thus, he notes, the older and well-established focus on macrobotanical remains has been augmented to include several productive ways of tackling archaeological evidence at microscopic and even molecular levels of resolution. Pollen analyses—long a staple of such research—has been joined by analyses of minutiae as elusive as phytoliths, lipids, and starches, all of which are carefully surveyed as research enterprises in their own right in one or more of these papers. Furthermore, AMS dating is now also a great help. In short, paleoethnobotany is stronger today than it has ever been. Thanks to minutiae.

Yet, as Hart also explains, there are weaknesses to be confronted. Too little is known, for instance, about indige-

nous uses of crops in eastern North American prior to the widespread cultivation of maize in the last thousand years or so. As McConaughy remarks (this volume, page 24):

The early Late Woodland (ca. A.D. 400 to 900) is a very important transition period between the Middle Woodland Hopewellian efflorescence and development of intensive maize horticulture societies during the late Late Woodland/Late Prehistoric period in Pennsylvania and the northern panhandle of West Virginia. Unfortunately, the early Late Woodland is also one of the least studied periods in the region. Much more work must be directed toward identifying and excavating sites from the early Late Woodland period. It is only through such work that the questions of when and how settled village life and maize horticulture developed will be answered.

Even when there is solid evidence now in hand, figuring out what the available evidence shows us is not easy. Knowing, for instance, what was being cooked (or otherwise processed) in pots in prehistoric times has proved to be a lot harder to pin down than perhaps formerly expected. In Hart's words, more experimental work is needed "to determine the relationships between the foods cooked in pots, the resulting charred cooking residues, and carbon isotope values."

There are other current weaknesses. "One of the challenges of interpretation for maize remains in Late Woodland southern New England is the difficulty of locating a ratio or other technique that will allow comparison across such a large range of sites with radically different preservation and even excavation techniques" (Stein, page 64). "However, the presence or absence of morphologically distinct phytoliths in many plants indigenous to North America is not yet known. In addition, phytolith systematics and taxonomy are not universal and a standard classification still needs to be accepted" (Serpa, page 101). As weaknesses go, these are pretty basic. Yet perhaps the most telling is a weakness identified by Hart and others in this volume: theory. Or as Bellwood might phrase it, how to build the hard-won minutiae of evidence into properly big pictures.

What about opportunities for future paleoethnobotany in the Northeast? As the chapters in this volume show, there is every reason to believe that the archaeological recovery of further macro- and microbotanical remains—such as the extraction and analysis of phytoliths from such secure contexts as cooking residues left on potsherds, as well as yet further advances in the recovery and identification of starch grains—will continue to be productive avenues for work. Furthermore, given what is happening so often these days in the field of DNA

research, Hart is surely right to point out that improvements in this arena, too, in coming years may greatly refine our understandings of crop histories and the human impacts on species somewhat misleadingly labeled "domestication." As Robert Browning suggested, researchers in paleoethnobotany have every right to intone: "Grow old with me! The best is yet to be . . ."

What about future threats? An obvious one, of course, is site destruction, and its evil twin, cultural resource management analyses that get put off for lack of proper funding. But let us not forget that weaknesses can also serve as threats. In Hart's opinion, there is presently "a strong need to tie to theory the methods and techniques used to develop lines of evidence about prehistoric plant-human relationships" (page 3). If this is true, then he may well be too generous when he adds (page 4): "Theoretically, there has been a move away from the traditional categories of hunter-gatherer and agriculturist with a recognition that such categories hide much of the variation that characterizes human subsistence strategies." While I am not sure what Hart means here by "theoretically," I would observe more pessimistically that the convention of using these two descriptive labels—Ninian Stein calls them "constructs"—to describe how people make a living is still blinding many of us to the diversity and complexity of the human past, all that Bellwood (2005) and Diamond (1997, 2005; Diamond and Bellwood 2003) have written not withstanding.

THE BIG PICTURE

It would be hard to deny that however refined by years of scholarship, the constructs "hunter-gatherers" and "agriculturalists" are what linguists call folk categories, not what experts would see as well-defined economic statuses. Just as there is no agreement today in archaeology or anthropology on what terms such as "bands" and "chiefdoms" mean, so too, there is little scholarly (as opposed to popular) consensus on what the terms "hunter-gatherer" and "agriculturalist" mean, or even if we should still be using such terminology.

These are not trivial concerns, although I realize there are those nowadays who make no distinction between folk and scientific ways of understanding the world. Yet it is difficult become passionate about more than minutiae if what facts are supposed to add up to remains elusive, unknown, or strongly contested. In this regard, I think Hart is being diplomatic (and a little obscure) when he tells us: "What is clear is that the persistence of the use of traditional categories constrains paleoethnobotanical investigations and may even channel those investigations to specific, anticipated results" (page 4). I think what he is saying is that our categories, constructs, terms, or labels

should not be wishes, and we must be careful lest how we talk about things becomes self-fulfilling prophecies about what big pictures things fit into.

What am I getting at? How we decide to *people* our big pictures of the past plays a decisive role in what the pictures show us (Terrell 2006, 2007). As I read through these contributions, several basic questions came to mind that I am unsure of how archaeobotanists working in the Northeast would answer:

Question #1: Given how hard it is to pin down archaeobotanical evidence, why do we have to know about what people were eating in the past? Is it to make our pictures of the past more historically accurate—to properly flesh them out, so to speak? Or for some other reason, or reasons?

Question #2: What difference does it make whether something harvested by people in the past was wild or domesticated? Food is food, wood is wood, and thatch is thatch, right? Surely people would not have bothered with something wild if it were too much work or offered too little reward. So what is the point of drawing this distinction?

Question #3: Why do we need to know whether people were hunter-gatherers or agriculturalists in the past? Would how we label them have made any difference to them?

These are only some of the simple questions that came to mind as I read these chapters. You may find them silly, or see the answers to such elementary questions as self-evident. I am pretty sure I know how scholars such as Bellwood or Diamond would answer them (Terrell 2005, 2007; Bellwood 2007). But what about the authors of this collection?

It is popular these days in some academic circles, particularly among biological anthropologists studying the prehistory of the Pacific Islands, to talk about “proxy data” (e.g., Fairbairn 2005; Matisoo-Smith and Robins 2004; Oppenheimer 2004). Thus, for example, Catherine Hill and her colleagues (2007) recently noted that for many archaeologists working in the Pacific, the first appearance of pottery in the region is proxy evidence for the arrival of Taiwanese “Austronesians.” Saying this is, for many, an obscure way of saying that not only potters but supposedly also early agriculturalists had arrived in the Pacific from an assumed center of domestication somewhere in Asia. Why? Because it is popularly taken for granted, possibly for sound reasons, that nobody would have been able to colonize the far-flung and hitherto uninhabited islands of the central and eastern Pacific

if they had not taken with them in their canoes nutritionally beneficial plants and animals.

From this interpretative vantage point, it is fairly certain that at least some working in the Pacific today would agree with Bellwood (2005) that archaeobotanical evidence bearing on the cultivation of plants and the husbandry of animals can serve as proxy data for deciding whether those responsible for the remains and residues were headed down the road, both figuratively and literally, to higher civilization—or to use an archaeological expression still widely favored in the United States, whether those involved should be put somewhere in the great interpretative canvass titled “The Evolution of Complex Society.” In contrast, judging by what Hart and others say in this volume, this is not necessarily the big picture that archaeobotanists working in the Northeast have in mind. If so, then it is not always clear in these chapters what they see botanical evidence as proxy for when it comes to human beings.

Nonetheless, what does come across in what Bendremer and Thomas, Chilton, Morenson and Largy, and Stein in particular, tell us is that getting big pictures right, whatever they portray, is not just of academic concern. As Stein observes:

Perhaps one of the reasons that subsistence in pre-Contact and Contact Period New England has been so controversial is because it challenges several English cultural dichotomies that persist as powerful remnants in our culture to this day. Specifically, Native American subsistence during the Contact Period ca. 1600-1700 AD challenged the English concepts of “nature” versus “culture” and the related dichotomy of cultivation versus foraging. (page 61)

In her estimation, how we characterize pre-Contact subsistence in New England is controversial because how people in the Northeast made a living in the past was *liminal* (“between categories”): what they did had some of the characteristics both of foraging and of cultivating. Importantly, she adds, “there is no evidence to indicate that Algonquian-speaking Native peoples in New England considered foraging and agriculture to be dichotomous resource acquisition strategies” (page 62).

A similar thought is voiced in an equally compelling way by Chilton in her chapter on understanding the local adoption of maize. She points out that at the heart of current debate on the role of maize in prehistoric times in this part of the world is continuing disagreement over how to interpret the archaeological evidence at hand. Debate is “often framed by dichotomous reasoning centered on whether or not New England Algonquian were sedentary farmers prior to European Contact” (page 53). As others

also do in this collection, Chilton notes that simply finding botanical evidence at an archaeological site and pinning down its antiquity are together not enough to say how important maize (or for that matter, any other species) was in pre-Contact Native American life. In this regard, a recurrent theme in these chapters is the unmistakable variability of subsistence and settlement patterns in the ancient Northeast.

Although no comment is needed, it should also be mentioned that the contributors to this volume clearly know that the results of their research are also of far more than scholarly interest to today's living descendants of the people who were exploiting the plants that archaeologists are now studying through residues and other traces of their former existence.

DOMESTICATED LANDSCAPES

It was my impression reading these papers, therefore, that what should be made of the results being achieved by archaeobotanists in the Northeast is currently moot. Messner and his co-authors report that there is good reason to think advances in archaeobotanical inquiry will improve our understanding of the past. "Analyses that provide data on what species were being exploited during specific time periods allow researchers to answer broader questions regarding Native American resource selection, ecological interaction and manipulation, inter-regional group relationships via trade and exchange, and change over time in subsistence strategies" (page 111). Yes, but how so? Since it appears that archaeologists in the Northeast are not particularly comfortable with evolution-of-complex-society depictions of the past, and evidently there is no consensus on what alternative big pictures are worth striving for, there are decisions to be made if archaeobotanical research is to forge ahead productively.

For example, there is a hint in a few of these essays that a promising alternative big picture to strive for might be one that could be titled "The Amazing Story of Maize and How It Did (or Didn't) Transform the Northeast." Perhaps, but not necessarily. Judging at any rate by what some of these authors report, not enough is known or currently conjectured about the effects that maize cultivation may have had on the economies of people. Hence it would seem risky to pin one's hopes too much on maize. Said differently, something—say, maize—cannot be a proxy for something else—say, big permanent settlements—until the connection between an inferred proxy and what it supposedly stands for is clearly understood and agreed upon. Judging by what is reported in this collection, maize in the Northeast does not yet fit the bill.

I am not preaching gloom. It is worth bearing in mind that the kinds of pictures, big or small, that archaeologists

can expect to make are not photographs. They are never portrayals captured all at once on some kind of light-sensitive medium, chemical or digital. Archaeological pictures always must be sketched or otherwise created by applying the interpretative equivalent of numerous individual brushstrokes. Therefore, while advice is cheap, my advice would be that archaeologists working in the Northeast should be wary of anyone peddling big pictures of the past. Such a way of seeing the purpose of archaeology far too easily encourages us to fit facts into the frames we hope they fill. To shift metaphors, nobody would claim that facts (or minutiae) speak for themselves. By the same token, facts should not be treated like ventriloquist's dummies.

How then should the dialogue between fact and theory be orchestrated (to shift metaphors yet again!)? It may seem unscientific to say so, but as I have already suggested, a first step might be to accept (what might be called) a "willing suspension of belief" in big pictures about the evolution of cultural complexity, the impact of agriculture on human mobility and waves of demographic advance (Bellwood and Renfrew 2002), and so forth. I would argue that what is needed instead are good portrayals of how people and plants have shaped one another over time: pictures of their co-domestication, so to speak.

In this regard, there are two old questions long asked in archaeology that are still just as hard to answer as they have always been:

1. *What species of plants and animals were being exploited in the past? Equally important, what species were not being exploited?*

Basic information of both kinds is vital to understanding of how human beings have been exploiting, adapting to, and changing the world around them. Given the current popularity of big-picture doomsday environmental scenarios (e.g., Diamond 2005) as well as popular ideas about how the forebears of at least some of us once upon a time were much wiser in caring for Mother Earth than most of us are nowadays, reliable portraits of how people have truly been dealing with the world around them are needed. While qualitative (presence/absence) information about species exploitation and species availability may not be sufficient to answer all such questions, even simple tables summarizing good qualitative data could get us a long way down the road to the understandings needed.

2. *How did people exploit the species they used?*

This is the kind of basic question archaeologists love, but in practice find hard to answer. While it may be unconventional to do so, it can be argued

that (a) any species can be called domesticated when another species knows how to exploit it, and (b) how people have exploited other species has *always varied*, depending on the species in question and on how much of them people have wanted to exploit (Terrell et al. 2003). Furthermore, unlike species that focus much of their time and energy on finding and consuming a single species, or set of highly similar species, human beings domesticate (i.e., know how to exploit, or less formally, “know how to bring home the bacon”) not only many particular species but also entire landscapes. In this instance should landscapes should be taken to mean not only certain places, or types of places such as estuaries, coastal plains, and tropical forests, but also the species pool, or range of species inhabiting these places that a given species (in this case, us) exploits. Equally important is the obvious fact when people domesticate landscapes in this fashion, they use differing tactics depending on the particular species being taken and the amounts of each being sought. In some instances, the strategies used are predominantly behavioral. Those doing the taking adjust what they are doing to fit (to capture or take) the target resource being sought. In such instances, the exploitative behavior is commonly called foraging, hunting, or gathering. To make use of other species, however, the strategies followed may call for greater preparation and direct manipulation. In such instances, those doing the exploiting are more clearly *adapting*, rather than *adapting to*, the species they are taking, and convention says that such behavior should instead be called farming, cultivating, agriculture, or husbandry. Far more than perhaps generally seen, however, most people normally use a mix of acquisitive strategies—judging by the essays in this volume, the Northeast offers much evidence supporting this claim—which is why deciding whether people are to be called “foragers” or “farmers” may not only be hard to do, but may also be a fairly empty exercise in typological name-dropping (Terrell et al. 2003). When it comes to how people put food on the family table, a sound roof over their heads, and stores in the larder, there may be no right label, and in this instance, no label can be a proxy for knowing the actual details of what people really were doing.

CONCLUSION

I was gratified recently when archaeologists using several lines of evidence, including paleobotany, learned on

Rapa Nui (Easter Island) that this famous island’s prehistoric inhabitants had evidently not doomed themselves stupidly to near extinction by blindly overexploiting the local environment. The more likely story is more interesting. As paleobotanists have shown elsewhere, too, rats introduced intentionally or unintentionally by people can have a devastating impact on native vegetation. With no predators on Rapa Nui except perhaps people, rats introduced by the first settlers of this tiny island could have reproduced so quickly that their numbers would have doubled every six or seven weeks. A single mating pair could have given rise to almost 17 million rats in just over three years (Hunt 2006:418). To make this particular story short, it now seems probable that rats far more than people led to Easter Island’s dramatic deforestation.

I think the lesson for us here is that a little evidence can go a long way in demolishing even big and quite dramatic pictures of the past. The challenge facing paleoethnobotany in the service of archaeology is not perfecting ways of linking botanical evidence with human behavior so that the former can be used as proxy evidence about the latter (proving, say, that maize = a more sedentary lifestyle, or maize = greater social complexity). Rather, the big pictures we first need are basically ones that show us what people were actually doing to make a living, put a roof over their heads, and store something away in the larder, too. As Terry Hunt (2006:419) has written about his unexpected discoveries on Easter Island:

I believe that the world faces today an unprecedented global environmental crisis, and I see the usefulness of historical examples of the pitfalls of environmental destruction. So it was with some unease that I concluded that Rapa Nui does not provide such a model. But as a scientist I cannot ignore the problems with the accepted narrative of the island’s prehistory. Mistakes or exaggerations in arguments for protecting the environment only lead to oversimplified answers and hurt the cause of environmentalism. We will end up wondering why our simple answers were not enough to make a difference in confronting today’s problems.

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INDEX

Plant Common Names

- acorn 30, 35, 38, 39, 42, 43, 45, 113, 164, 178, 179, 180, 186
- alder 177, 179, 180
- alumroot 118
- amaranth 30, 40
- American alumroot 118
- American lotus 116, 117, 118
- apple 178, 179, 187
- arrow arum 116, 118
- ash 30, 35, 163
- awl-leaf arrowhead 118
- balsam fir 178, 179, 180
- barley 104, 109, 192
- barn grass 178
- barnyard grass 30, 40
- basswood 30, 35, 37
- bean (common) 3, 4, 12, 13, 16, 18, 22, 23, 29, 30, 31, 34, 35, 43, 73, 75, 76, 77, 78, 79, 87, 88, 90, 91, 94, 102, 104, 106, 107, 113, 116, 163, 166, 183, 184, 185, 186, 184, 189, 192, 193, 194, 195, 196
- bedstraw 30, 35, 38, 39, 40
- beech 29, 30, 32, 34, 35, 36, 37, 38, 44, 45, 46, 47, 163, 177, 178, 179, 180
- beechnut 35, 38, 39, 42, 45, 47, 180
- big bluestem 42
- birch 30, 35, 37, 46, 47, 163, 177, 178, 179, 180, 181
- bitternut hickory 30, 35, 38, 42, 45, 47
- bittersweet 118
- blackberry 30, 38, 46, 113, 118, 178, 179, 193
- black birch 30, 46
- black cherry 178, 179, 180
- black nightshade 30, 38, 40, 162
- black spruce 179
- black walnut 15, 30, 35
- blueberry 30, 35, 38, 40, 42, 44, 46, 178, 179
- blue cohosh 118
- bottle gourd 12, 102, 104
- buffalo gourd 102, 104
- bracken fern 118
- bramble 30, 35, 38, 39, 40, 42, 43, 45, 162, 165, 166
- brier 118
- bristly sarsaparilla 30, 38, 43
- broadleaf arrowhead 118
- buckwheat 104
- bulltongue arrowhead 118
- bunchberry 30, 38, 39, 43, 178
- butternut 30, 35, 37, 38, 42, 45, 46, 47, 48, 53, 54, 180, 186
- Canada plum 38
- cattail 163, 165, 166
- chenopod 13, 14, 15, 57, 162, 165, 166, 193, 194
- cherry 30, 35, 39, 45, 162, 179
- chestnut 29, 30, 32, 33, 34, 35, 36, 37, 38, 42, 44, 45, 46, 47, 48, 116
- chickweed 178
- chinquapin 116
- chokeberry 178
- chokecherry 38, 116
- chufa 118
- cinquefoil 118
- cleavers 162, 165, 166
- common pepperweed 102, 104
- coneflower 118
- corn: see maize
- cowslip 118
- crab apple 178
- cranberry 178, 179
- crested wood fern 118
- cucurbit 1, 3, 10, 11, 12, 34, 35, 42, 47, 88, 89, 93, 94, 163, 166, 168
- cupplant 118
- dewberry 30
- ditchgrass 178
- dock 178
- dogbane 118
- duck potato 118
- ed madi 194
- elderberry 30, 35, 38, 39, 40, 43, 46, 113, 178, 179, 180
- elm 30, 35, 163
- erect knotweed 9, 15, 22, 29, 30, 39, 43, 44, 102, 104
- false buckwheat 30, 45, 46
- false daisy 12
- fir 177, 178, 180
- five-finger 118
- flat-top goldentop 118
- fly honeysuckle 118
- giant hyssop 118
- giant ragweed 30, 39, 46
- golden club 112, 118
- goldenrod 118
- goosefoot 9, 22, 29, 30, 34, 35, 39, 40, 41, 42, 45, 46, 47, 102, 104, 180
- gourd 3, 4, 9, 10, 22, 30, 35, 39, 46, 47, 88, 89, 94, 104, 141, 142, 144, 145, 146, 147
- grape 30, 35, 38, 39, 43, 48, 162, 165, 193
- grass 38, 40, 42, 45, 101, 104, 108, 109, 163, 165, 166
- grassy arrowhead 18
- great bulrush 118
- groundnut 39, 118, 180
- harlequin blueflag 118
- hawthorn 30, 35, 38, 39, 40, 42, 45, 46, 162, 165
- hazelnut 30, 35, 38, 39, 42, 43, 45, 180, 186
- hemlock 29, 30, 32, 33, 34, 35, 36, 37, 38, 45, 46, 47, 179, 180
- hickory 30, 32, 33, 35, 36, 37, 38, 39, 42, 45, 46, 47, 53, 116, 162, 164, 166, 185, 186, 187
- hog peanut 30, 38, 118
- hophornbeam 30, 35, 47
- horsetail 118
- huauzontle 13
- huckleberry 30, 38, 40, 42, 53, 113
- ironwood 163
- Jack-in-the-pulpit 112, 118
- Jerusalem artichoke 118
- knotweed 15, 16, 30, 34, 45, 118, 166
- lady fern 118
- lady'slipper 118
- large Indian bread root 118
- lily 30, 40, 118
- little barley 2, 9, 15, 16, 17, 22, 30, 39, 40, 45, 46, 102, 104, 109
- lopseed 118
- maidenhair fern 118
- maize 1, 2, 3, 9, 12, 18, 19, 20, 21, 22, 23, 24, 29, 30, 31, 33, 34, 35, 37, 38, 39, 40, 42, 43, 45, 46, 47, 48, 53, 54, 55, 56, 57, 61, 62, 63, 64, 66, 68, 70, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 87, 88, 89, 90, 91, 92, 93, 94, 95, 101, 104, 106, 113, 116, 117, 119, 120, 121, 122, 123, 130, 131, 137, 147, 151, 152, 153, 155, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 183, 184, 185, 186, 187, 188, 189, 190, 192, 193, 194, 195, 196, 200, 201, 202, 203
- man-of-the-earth 118
- maple 29, 30, 32, 34, 35, 36, 37, 38, 44, 46, 47, 163, 177, 178, 179, 180, 181
- marshelder 17, 22, 29, 30, 34, 35, 39, 40, 45, 46, 47, 102, 104, 193
- maygrass 9, 16, 17, 22, 30, 39, 102, 104, 193
- meadow beauties 118
- meadow garlic 118
- meadow parsnip 118
- milkweed 12
- mountain ash 178
- mustard 104
- New Jersey tea 118
- nightshade 104, 162, 165
- oak 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 42, 44, 45, 46, 47, 113, 116, 117, 162, 163, 166, 179, 181, 185, 187

panic grass 40
 paper birch 178
 pawpaw 193
 peach 185, 195
 pecan 193
 peppergrass 163, 166
 pin cherry 30, 38, 40, 43, 116, 178
 pine 2, 3, 30, 46, 129, 133, 134, 179, 180
 pitch pine 30, 35, 46
 plain gentian 118
 plum 40, 45
 pokeweed 30, 35
 pondweed 178
 poplar 30, 35, 45, 177, 178, 180, 181
 prairie rose 118
 prickly ash 118
 prickly rose 116
 proliferous knotweed 118
 pumpkin 35, 39, 45, 88, 102, 104
 purslane 166
 raspberry 30, 38, 46, 53, 116, 178, 179, 180
 red baneberry 118
 red oak 47, 113, 163, 178, 180
 reed 118
 rice 62, 104
 river birch 30
 roundlobe hepatica 118
 sassafras 118
 sedge 2, 165, 178
 Seneca snakeroot 118
 serviceberry 118
 shagbark hickory 30, 47
 shield fern 118
 slippery elm 118
 smartweed 15, 16, 30, 35, 38, 39, 40, 42, 45, 48, 178
 snakeberry 118
 Solomon's seal 118
 sorrel 180
 spikenard 118, 162, 165, 166
 spike rush 178
 spotted geranium 118
 spruce 179, 181
 squash 1, 2, 3, 4, 9, 10, 12, 16, 22, 30, 35, 38, 39, 40, 43, 45, 46, 56, 75, 76, 87, 88, 89, 90, 91, 93, 94, 141, 142, 143, 144, 145, 146, 147, 148, 183, 184, 186, 189, 195, 196
 staghorn sumac 178, 179, 180
 Stinging nettle 118
 strawberry 30, 35, 38, 46, 78, 113, 162, 165, 166
 sugar maple 30, 35, 37, 46, 47, 179, 180
 sumac 30, 35, 38, 40, 43, 45, 163, 165, 166, 193
 sumpweed 9, 30
 sunflower 9, 16, 17, 18, 30, 35, 39, 40, 43, 44, 45, 46, 47, 57, 102, 104

swamp valerian 118
 sweet cicely 118
 sweetfern 30, 39
 sweetflag 118
 tall cinquefoil 118
 teosinte 3
 thicket bean 102, 104
 thimbleweed 118
 tick-trefoil 30, 38, 39, 43, 46
 tobacco 12, 13, 24, 29, 30, 34, 35, 39, 40, 44, 45, 46, 47, 102, 104, 162, 163, 165, 183, 186
 trailing woolly bean 102, 104
 tuckahoe 112, 116, 118
 tuber 39, 187
 Turk's cap lily 116
 veiny pea 118
 vervain 30, 35
 vine apple 89
 Virginia pepperweed 102, 104
 walnut 116, 161, 162, 164, 166
 watercress 179, 180
 wheat 104, 109, 192, 194
 wheatgrass 102, 104
 white birch 179
 white elm 30, 37
 white oak 47, 163
 white pine 2, 29, 30, 33, 34, 35, 36, 37, 38, 45, 46, 47, 179, 180
 white spruce 179
 white walnut 30, 48
 white waterlily 118
 wild geranium 118
 wild ginger 118
 wild onion 118
 wild potato 118
 wild raisin 30, 38, 39
 wild rice 2, 30, 34, 38, 40, 102, 104, 117
 wild rose 118
 wild rye 30, 38, 42, 43, 101, 104
 wild sarsaparilla 30, 38
 wood nettle 118
 yellow birch 30, 37
 yellowish gentian 118

Plant Scientific Names

Abies 176, 177, 178, 179, 180
Abies balsamea 178, 179, 180
Acer 30, 163, 177, 178, 180
Acer saccharum 30, 179
 Acoraceae 118
Acorus americanus 118
Actaea rubra 118
Adiantum pedatum 118

Agastache foeniculum 118
 Alismataceae 118
Allium canadense 118
Allium stellatum 118
Alnus 177, 179, 180
Amaranthus 30, 39
Amaranthus graecizans 107
Ambrosia trifida 30
Amelanchier canadensis 118
Amphicarpaea bracteata 30, 118
Andropogon gerardii 30
Anemone cylindrica 118
 Apiaceae 118
Apios americana 118, 180
 Apocynaceae 118
Apocynum androsaemifolium 118
 Araceae 118
Aralia hispida 30
Aralia nudicaulis 162, 166
Aralia racemosa 30, 118
 Araliaceae 118
Arisaema triphyllum 112, 118
Aronia 178
 Aristolochiaceae 118
Asarum canadense 118
 Asclepias 12
 Asteraceae 104, 108, 118
Athyrium filix-femina 118
 Berberidaceae 118
Betula 30, 163, 177, 178, 179, 180
Betula alleghaniensis 30
Betula nigra 30
Betula papyrifera 178, 179
 Brassicaceae 104
Caltha palustris 118
 Caprifoliaceae 118
Carex 178
Carya 2, 30, 116, 121, 162, 185, 187
Carya cordiformis 30
Carya ovata 30
Castanea dentata 30, 116
Castanea pumila 116
Caulophyllum thalictroides 118
Ceanothus herbaceus 118
 Celastraceae 118
Celastrus scandens 118
 Chenopodiaceae 104
Chenopodium 13, 14, 15, 30, 39, 43, 45, 162, 166
Chenopodium album 180
Chenopodium berlandieri 9, 13, 14, 30, 35, 39, 40, 41, 42, 46, 47, 102, 104, 105, 108, 193
Comptonia peregrina 30
Cornus canadensis 30, 178
Corylus 30
Corylus cornuta 180

- Crataegus* 30, 162
 Cruciferae 166
Cucurbita 2, 108, 117, 141, 142, 143, 144, 145, 146
Cucurbita foetidissima 102, 104, 105, 107, 108
Cucurbita pepo 3, 9, 10, 11, 30, 39, 87, 88, 89, 92, 102, 104, 105, 107, 108, 143, 144, 145, 146, 147, 163
 Cucurbitaceae 104, 108
Cuscuta 121
 Cyperaceae 118
Cyperus 2
Cyperus esculentus 118
Cypripedium 118
 Dennstaedtiaceae 118
Desmodium 30
Dioscorea villosa 118
 Dioscoreaceae 118
 Dryopteridaceae 118
Dryopteris cristata 118
Echinochloa 30
Echinochloa crusgalli 178
Eclipta 12
Eleocharis 178
Elymus 30, 104, 105, 109, 119, 123
Elymus canadensis 101, 104, 105, 108, 109
Elymus caninum 102, 104, 105, 108, 109
Elymus glabriflorus 106
Elymus virginicus 101, 104, 105, 106, 108, 109
Erythrobalanus 113, 116
Erythronium 118
 Equisetaceae 118
Equisetum 118
Euthamia graminifolia 118
 Fabaceae 104, 108, 118
Fagus 177, 178, 179, 180
Fagus grandifolia 30, 163, 179, 180
Fragaria 30, 162
Fraxinus 30, 163
Galium 30, 162, 166
Gaylussacia 30
Gentiana alba 118
 Geraniaceae 118
 Geraniaceae 118
Geranium maculatum 118
 Gramineae 163, 166
Helianthus 30, 43, 44
Helianthus annuus 9, 17, 18, 30, 43, 46
Helianthus decapetalus 43
Helianthus divaricatus 43
Helianthus maximiliani 102, 104, 105, 108
Helianthus strumosus 43
Helianthus tuberosus 118
Hepatica nobilis 118
Heuchera americana 118
Hordeum 103, 119, 123
Hordeum pusillum 2, 9, 15, 17, 30, 40, 46, 102, 104, 105, 108, 109, 122
Hordeum vulgare 109
Ipomoea pandurata 118
 Iridaceae 118
Iris versicolor 118
Iva annua 9, 17, 30, 39, 40, 46, 102, 104, 105, 108, 193
Juglans 116, 162
Juglans cinerea 30, 121, 180
Juglans nigra 30
Juniperus 176
Lagenaria siceraria 11, 12, 102, 104, 105, 107, 108
 Lamiaceae 118
Laportea canadensis 118
Lathyrus venosus 118
 Lauraceae 118
Lepidium densiflorum 102, 104, 105, 108, 163, 166
Lepidium virginicum 102, 104, 105, 108, 163, 166
 Liliaceae 30, 118
Lilium 116
Lilium superbum 116
Lonicera canadensis 118
Malus 179
Media chilensis 194
 Melastomataceae 118
Nasturtium officinale 179, 180
Nelumbo lutea 116, 117, 118
 Nelumbonaceae 118
Nicotiana 13, 30, 44
Nicotiana rustica 12, 44, 102, 104, 105, 108, 162, 163
Nuphar advena 116
Nymphaea odorata 118
 Nymphaeaceae 118
 Oligoneuron 118
 Orchidaceae 118
Orontium aquaticum 112, 118
Oryza 104
Oryza sativa 104
 Oryzeae 105
 Oryzoideae 105
Osmorhiza longistylis 118
Ostrya virginiana 30
Oxalis 180
Peltandra virginica 112, 116, 118
Phalaris caroliniana 9, 16, 17, 30, 102, 104, 105, 106, 108, 193
Phaseolus 107, 108, 193
Phaseolus polystachios 102, 104, 105, 107, 108
Phaseolus vulgaris 22, 23, 30, 87, 90, 93, 102, 104, 105, 108, 116, 163, 185, 187
Phragmites australis 118
Phryma leptostachya 118
Phytolacca americana 30
Picea 176, 177, 179, 180
Picea glauca 179
Picea mariana 179
Pinus 30, 134, 176, 179, 180
Pinus rigida 30
Pinus strobus 30, 179, 180
 Poaceae 101, 104, 106, 107, 108, 118, 119, 120, 121, 122, 123
Polygala senega 118
 Polygalaceae 118
 Polygonaceae 104, 118
Polygonatum biflorum 118
Polygonum 15, 16, 30, 45, 121, 166, 178
Polygonum erectum 9, 15, 16, 30, 43, 44, 102, 104, 105, 108, 118
Polygonum hydropiperoides 118
Polygonum pennsylvanicum 118
Polygonum ramosissimum 118
Polygonum scandens 30, 45
Populus 30, 177, 178, 179, 180
Portulaca oleracea 166
Potamogeton 178
Potentilla arguta 118
Potentilla monspeliensis 118
Prunus 30, 162, 165, 178, 179
Prunus nigra 30
Prunus pennsylvanica 30, 116
Prunus persica 185
Prunus serotina 179
Prunus virginiana 116
Psoralea esculenta 118
 Pteridaceae 118
Pteridium aquilinum 118
 Punicaceae 118
Pyrus 178
Quercus 30, 113, 116, 117, 120, 121, 122, 123, 162, 179, 180, 185, 187
Quercus alba 163, 179
Quercus coccinea 122
Quercus rubra 163, 178, 180
 Ranunculaceae 118
 Rhamnaceae 118
Rhexia mariana 118
Rhexia virginica 118
Rhus 30
Rhus typhina 163, 166, 178, 179, 180
Rosa acicularis 116
Rosa arkansana 118
 Rosaceae 118
Rubus 30, 121, 162, 178, 179
Rubus allegheniensis 118
Rubus canadensis 179
Rubus idaeus 116, 179
Rudbeckia laciniata 118

<i>Rumex</i> 178	<i>Solanum nigrum</i> 162	<i>Valeriana uliginosa</i> 118
<i>Ruppia maritima</i> 178	<i>Sorbus americana</i> 178	Valerianaceae 118
Rutaceae 118	<i>Stellaria</i> 178	<i>Verbena</i> 30
<i>Sagittaria</i> 116	<i>Strophostyles helvula</i> 102, 104, 105, 108	Verbenaceae 118
<i>Sagittaria graminea</i> 118	<i>Thaspium barbinode</i> 118	<i>Viburnum</i> 178, 179
<i>Sagittaria lancifolia</i> 118	<i>Tilia americana</i> 30	<i>Viburnum cassinoides</i> 30
<i>Sagittaria latifolia</i> 118	<i>Triticum</i> 104	<i>Vaccinium</i> 30
<i>Sagittaria subulata</i> 118	<i>Tsuga</i> 176, 179	<i>Vitis</i> 30, 162
<i>Sambucus</i> 30	<i>Tsuga canadensis</i> 30, 179, 180	<i>Zanthoxylum americanum</i> 118
<i>Sambucus canadensis</i> 178, 179	<i>Typha latifolia</i> 163, 166	<i>Zea mays</i> 2, 20, 21, 30, 87, 89, 92, 101, 102, 104, 105, 108, 116, 117, 121, 162, 185, 187
Saxifragaceae 118	Ulmaceae 118	<i>Zizania</i> 30, 104, 105, 117
<i>Schoenoplectus tabernaemontani</i> 118	<i>Ulmus</i> 30	<i>Zizania aquatica</i> 2, 102, 104, 105, 106, 108
<i>Silphium perfoliatum</i> 118	<i>Ulmus americana</i> 30, 163	<i>Zizania palustris</i> 102, 104, 105, 106, 107, 108
Smilacaceae 118	<i>Ulmus rubra</i> 118	Zizanieae 105
<i>Smilax</i> 118	<i>Urtica dioica</i> 118	
Solanaceae 104	<i>Vaccinium</i> 179	
<i>Solanum americanum</i> 30, 38, 162	<i>Vaccinium angustifolium</i> 178, 179	

INDEX

Current Northeast Paleoethnobotany, New York State Museum Bulletin 494 (1999)

Plant Common Names

- acorn 17, 52, 54, 61, 62, 102, 113, 114, 122, 124, 162, 198, 203, 204, 205, 206, 215, 217
- alder 201
- amaranth 207, 209
- American elm 201
- artemisia, 28
- artichoke 28
- ash 184, 186, 192, 194, 197, 201, 202, 214, 219
- balsam fir 194
- barley 217
- basswood 102, 194, 201
- bean (common) 1, 3, 5, 13, 14, 15, 16, 17, 19, 20, 21, 27, 36, 47, 48, 50, 52, 53, 54, 55, 60, 61, 62, 63, 65, 74, 95, 121, 125, 133, 134, 136, 137, 142, 148, 161, 162, 198, 204, 209, 212, 213, 231
- bedstraw 14, 102, 142, 208, 209, 214, 217
- beech 186, 191, 194, 197, 201, 202, 205, 214, 215, 218, 219
- beechnut 142, 203, 205, 206, 215, 217
- big blue-stem 125, 209, 212
- birch 186, 188, 191, 194, 197, 201, 214
- blackberry 17, 19, 77, 102, 114, 197, 214
- black birch 218
- black currant 142
- black spruce 181
- black walnut 17, 142
- blueberry 102, 114, 140, 142, 204, 207, 210, 217
- bottle gourd 17, 19
- bracken fern 184
- bramble 75, 197, 210
- bristly sarsaparilla 197, 208, 209
- buckwheat 75
- bullrush 102, 142
- bunchberry 102, 197, 207, 209
- buttercup 4, 74, 75, 76, 210, 212
- butternut 17, 52, 54, 61, 62, 79, 80, 102, 140, 142, 193, 201, 203, 205, 206, 214, 217
- Canada plum 207, 209, 231
- cattail 182, 186, 188
- cedar 186, 198
- chenopod 2, 12, 13, 14, 16, 20, 21, 96, 207, 227, 228
- cherry 192, 201, 202, 207, 209
- chestnut 113, 114, 140, 142, 161, 162, 194, 205, 215, 217
- chickweed 73
- chokecherry 142, 207, 210
- chrysanthemum 28
- cleavers 102, 227
- common lousewort 208
- composite 184
- corn: see maize
- cranberry 140, 142, 162
- cucurbit 191, 208, 215, 227, 230
- dahlia 28
- daisy 28
- dangleberry 102
- dewberry 77, 197, 207, 214
- dogwood 209, 212
- eastern hemlock 184
- eastern larch 184, 186
- elderberry 73, 74, 75, 77, 102, 142, 207, 210
- elm 184, 186, 194
- erect knotweed 12, 14, 16, 17, 19, 20, 21, 207
- fir 184, 186, 197, 198
- foxtail 102
- goosefoot 14, 18, 19, 20, 27, 73, 75, 102, 136, 142, 207, 208, 209, 214, 217
- gourd 2, 4, 5, 12, 19, 21, 27, 63, 191, 212, 217
- grape 17, 75, 102, 114, 142, 197, 207, 210
- grass 75, 146, 182, 184, 209, 211, 212, 214, 217, 218, 231
- gray birch 201
- green alder 184
- green amaranth 73
- groundnut 52, 114, 140, 142, 161, 162, 206, 231
- hackberry 77, 207
- hawthorn 52, 54, 60, 61, 62, 74, 102, 201, 207, 209, 215
- hazel 184, 218
- hazelnut 17, 102, 122, 124, 142, 203, 205, 206, 214, 217
- hemlock 50, 184, 186, 194, 201, 202, 217, 219, 228
- hickory 17, 19, 36, 79, 80, 102, 110, 113, 114, 122, 124, 125, 140, 142, 194, 205, 217
- hog peanut 207, 209
- huckleberry 102, 207, 209
- ironwood 194, 201, 202
- jack pine 194
- jewelweed 102, 142
- Jerusalem artichoke 114, 140, 142
- juniper 186
- knotweed 4, 96, 102, 114, 136, 231
- lamb's quarters 102
- larch 194, 201
- leather leaf 182
- lettuce 28
- lily 209, 212, 227
- little barley 2, 12, 14, 16, 18, 20, 21, 27, 96, 102, 136, 228
- loosestrife 182
- lousewort 208, 209, 212
- maize 1, 3, 4, 5, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 27, 30, 31, 36, 39, 40, 41, 47, 48, 50, 52, 53, 54, 55, 58, 60, 61, 62, 63, 65, 72, 74, 75, 77, 78, 80, 81, 82, 85, 87, 89, 91, 95, 96, 97, 102, 111, 113, 114, 121, 125, 133, 134, 136, 137, 140, 142, 143, 144, 145, 146, 147, 148, 157, 158, 160, 161, 162, 163, 164, 165, 167, 170, 171, 191, 192, 193, 198, 202, 204, 205, 206, 208, 212-213, 214, 215, 217, 225, 228, 229, 230, 231
- maple 188, 191, 192, 197, 201
- marshelder 14, 136
- maygrass 12, 14, 16, 20, 27, 96, 136, 207
- millet 75
- moss 182
- mountain maple 184
- mustard 227
- nightshade 102, 142
- oak 142, 184, 186, 191, 194, 201, 202, 205, 215, 217
- partridgeberry 102
- pea 209, 214, 217
- peach 19
- peat 182
- pigweed 73, 102, 142
- pin cherry 210, 214
- pine 186, 192, 197, 198, 201, 202, 214, 215, 219
- pitch pine 197
- plum 36, 52, 54, 102, 114, 142
- poison ivy 78
- pokeweed 102, 142
- pondweed 182
- poplar 184, 186, 188, 194, 201, 202
- potato 204
- prune 217
- pumpkin 5, 95, 204, 214, 217
- purslane 13, 14, 17, 73, 77
- quill wort 182
- raspberry 19, 77, 102, 110, 114, 125, 140, 142, 197, 207, 214
- red currant 142
- red maple 186, 188, 194, 217
- red oak 192, 193, 194, 201, 202, 205, 206, 213, 214, 219
- rush 182
- scrub oak 197
- sedge 75, 102, 142, 182, 184, 209, 212, 231
- serviceberry, 54
- shagbark hickory 17, 205, 215
- shrub birch 184
- smartweed 102, 114, 142, 209, 212
- Solomon's seal 102, 142, 214

speckled alder 184
 spike rush 182
 spruce 184, 186, 192, 194, 197, 198, 201, 202, 209, 212, 215, 219
 squash 1, 3, 5, 11, 12, 13, 14, 16, 17, 19, 20, 21, 27, 28, 34, 36, 47, 48, 50, 52, 53, 54, 63, 65, 95, 133, 136, 137, 142, 209, 214, 217, 231
 staghorn clubmoss 184
 St. John's wort 182
 stone wort 182
 strawberry 36, 114, 140, 142, 162, 204, 207, 209, 214, 217
 sugar maple 184, 186, 192, 194, 201, 202, 217
 sumac 13, 14, 17, 102, 114, 142, 208, 210, 231
 sumpweed 12, 13, 27, 96, 207
 sunflower 2, 12, 13, 14, 16, 17, 18, 19, 21, 27, 28, 29, 30, 31, 33, 34, 36, 39, 40, 41, 96, 125, 136, 137, 207, 208, 209, 229, 231
 sweetfern 208, 209
 tick-trefoil 14, 207, 208, 209, 217
 tobacco 13, 18, 21, 214, 229
 viburnum 77, 210
 walnut 52, 54, 80, 102, 114, 122, 125, 140, 162
 water lily 161, 182
 water nymph 182
 water plantain 182
 wheat 210, 214, 217
 white ash 194
 white birch 188
 whitehorn haws 142
 white oak 184, 192, 194, 201
 white pine 184, 186, 194, 207, 217
 white walnut 80
 wild bean 207, 227
 wild cherry 102
 wild pea 214
 wild raisin 207, 210
 wild rice 18, 20, 102, 142
 wild rye 209, 212
 wild sarsaparilla 208, 209
 wood-betony 208
 wood-sorel 73, 231

Plant Scientific Names

Abies 184
Abies balsamea 197
Acer 201
Acer rubrum 186
Acer saccharum 184, 201, 202
Acer spicatum 184
Agrestes 28
Alisma 182
Alnus 201
Alnus incana 184

Alnus viridis 184
Amaranthus 69, 102, 108-109, 113, 124, 142, 207, 208, 209
Amaranthus retroflexus 73
Amelanchier canadensis 54
Amphicarpaea bracteata 207, 209
Andropogon gerardii 125, 209, 212
Apios americana 114, 142, 162, 206, 231
Aralia hispida 197, 208, 209
Aralia nudicaulis 208, 209
Asteraceae 184
Asteroideae 28
Betula 184, 198
Betula populifolia 201
Brassicaceae 227
Caprifoliaceae 77
Carex 182
Carya sp. 17, 79, 102, 104-107, 122, 142
Carya ovata 17
Caryophyllaceae 73
Castanea dentata 113, 142
Celtis 77
Chamaedaphne 182
Characeae 182
Chenopodium 3, 4, 5, 19, 69, 73, 74, 77, 101, 102, 108-109, 110, 113, 114, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 133, 136, 142, 146, 207, 209, 227, 228, 230
Chenopodium album 73, 207
Chenopodium berlandieri 2, 12, 17, 27, 77, 96, 121, 126, 127-128, 130, 136, 207, 208, 217, 228
Chenopodium bushianum 126, 130
Chenopodium gigantospermum 227, 228
Chenopodium hybridum 207
Chenopodium macrocalycium 126
Chenopodium paganum 207
Ciliares 28
Compositae 73
Comptonia peregrina 208, 209
Cornus 209, 212
Cornus alternifolia 209
Cornus canadensis 102, 197, 207, 209
Corylus 102, 104-107, 142, 184, 206
Corylus americana 17
Crataegus 52, 54, 60, 61, 102, 201, 207, 209
Crataegus tomentosa 142
Cucurbita 27, 136, 142, 198, 209, 214, 227
Cucurbita pepo 1, 2, 4, 5, 11, 47, 52, 54, 63, 95, 191, 212, 213, 217
Cyperaceae 74, 75, 77, 184, 209, 212
Cyperus 102, 108-109, 113, 142
Desmodium 207, 209, 217
Divaricati 28
Eleocharis 182
Elymus 209, 212
Fabaceae 209, 212

Fagus grandiflora 142, 201, 202, 206
Fragaria 207, 209
Fragaria vesca 142
Fraxinus 184, 201, 202
Galium 102, 108-109, 113, 142, 208, 209, 227
Gaylussacia 102
Gaylussacia baccata 207, 209
Gramineae 73
Heliantheae 28
Helianthus 28, 29, 137, 207, 208, 209
Helianthus annuus 2, 12, 27, 28, 29, 96, 125, 136, 207
Helianthus tuberosus 114, 142
Hordeum 102, 108-109, 113, 137
Hordeum pusillum 2, 12, 27, 96, 136
Impatiens 102, 108-109, 113, 142, 228
Isoetes 182
Iva annua 12, 27, 136, 207, 228
Juglans 102, 104-107, 122
Juglans cinerea 17, 52, 54, 61, 62, 79, 142, 201, 205
Juglans nigra 17, 52, 54, 80, 142
Juncus 182
Juniperus 186
Larix 184
Larix laricina 201
Lathyrus palustris 214
Liliaceae 209, 212
Lycopodium clavatum 184
Lysimachia 182
Mitchella repens 102
Najas 182
Nicotiana rustica 13
Nuphar 182
Nymphaea 182
Ostrya virginiana 201
Paniceae 74, 75
Panicum 125
Pedicularis canadensis 208, 209
Phalaris caroliniana 12, 27, 136, 207
Phaseolus vulgaris 1, 13, 47, 52, 54, 61, 95, 125, 136, 142, 209, 213, 214
Phytolacca 102, 108-109, 113, 142
Picea 184, 197, 201, 202, 209
Picea mariana 181
Pinus 197, 201, 202, 212
Pinus strobus 184, 207
Pisum sativum 209, 214
Poaceae 182, 184, 209, 212
Polygonaceae 74, 75, 77
Polygonatum 113, 142
Polygonatum commutatum 102, 108-109
Polygonum 102, 108-109, 113, 114, 142, 209, 212
Polygonum erectum 4, 12, 27, 96, 136, 207
Populus 184, 201, 202

Portulaca sp. 17
Portulaca oleracea 13, 73, 77
Potamogeton 182
Prunus 102, 201, 202, 207, 209
Prunus americana 52, 54, 142
Prunus nigra 207, 209, 231
Prunus pennsylvanica 207, 210
Prunus virginiana 142, 207, 210
Pteridium aquilinum 184
Ostrya virginiana 202
Quercus 17, 54, 61, 62, 102, 104-107, 122, 142, 184, 201, 202, 205
Ranunculus 4, 74, 75, 76, 77, 210, 212
Ranunculus abortivus 76
Ranunculus bulbosus 76
Ranunculus scleratus 76
Rhus 13, 102, 113, 114, 142, 208, 210
Rhus toxicodendron 78
Ribes floridum 142
Ribes rubrum 142
Rubus 74, 75, 77, 102, 114, 125, 142, 197, 207, 210
Rubus hispidus 77
Sambucus 102, 142, 207, 210
Sambucus canadensis 73, 75, 77
Scirpus 102, 108-109, 113, 142
Solanum 102, 108-109, 113, 142
Sphagnum 182
Stellaria 73
Thuja 186
Tilia 102, 108-109, 113
Tilia americana 201
Triadenum 182
Triticum aestivum 210, 214
Tsuga canadensis 184, 201, 202, 228
Typha 182, 188
Ulmus 184
Ulmus americana 201
Vaccinium 102, 142, 207, 210
Vaccinium macrocarpon 142
Viburnum 210
Viburnum cassinoides 207, 210
Vitis 74, 75, 102, 142, 197, 207, 210
Zea 113
Zea mays 1, 11, 47, 54, 61, 72, 74, 75, 77, 85, 102, 108-109, 125, 136, 142, 212
Zizania 113
Zizania aquatica 18, 102, 108-109, 142

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